

100-443886-100

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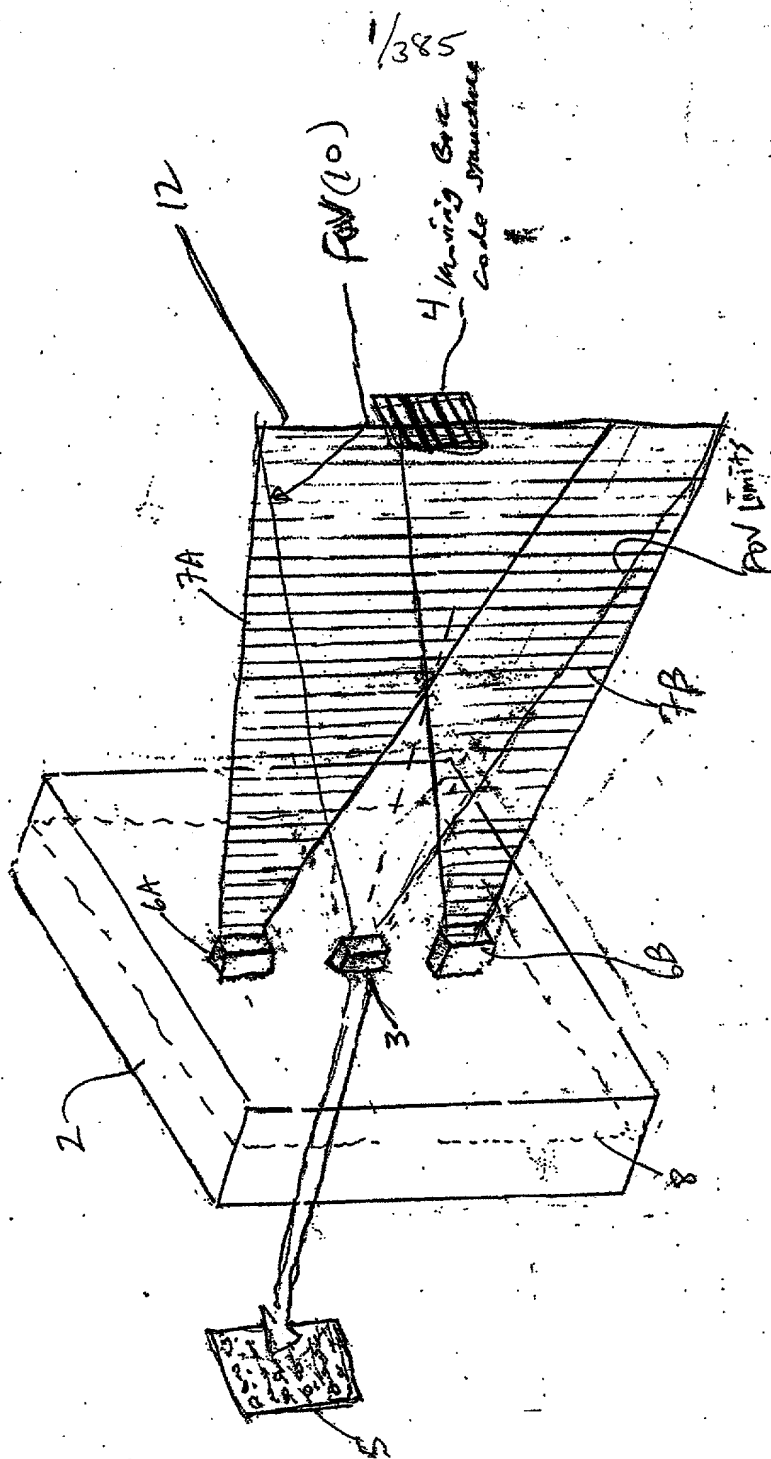
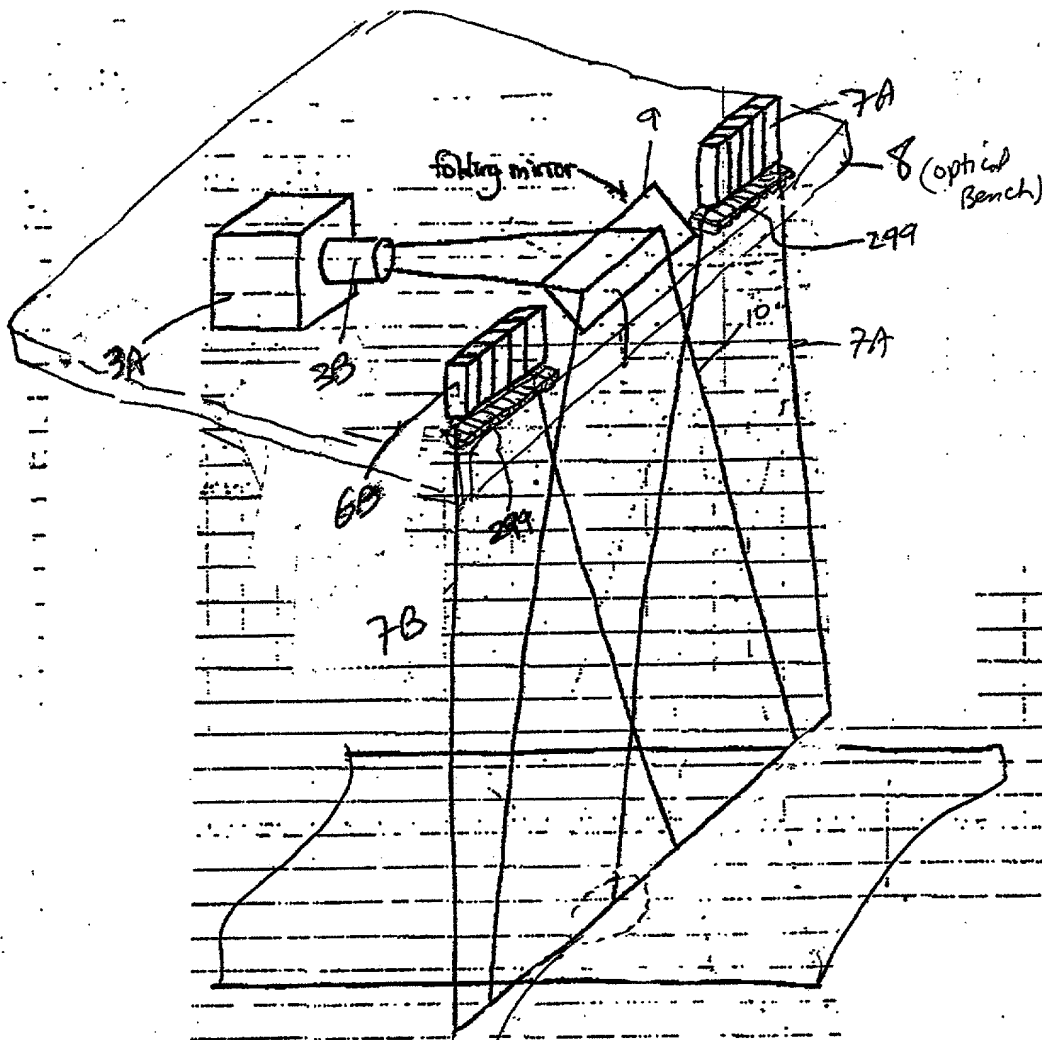


FIG 1A

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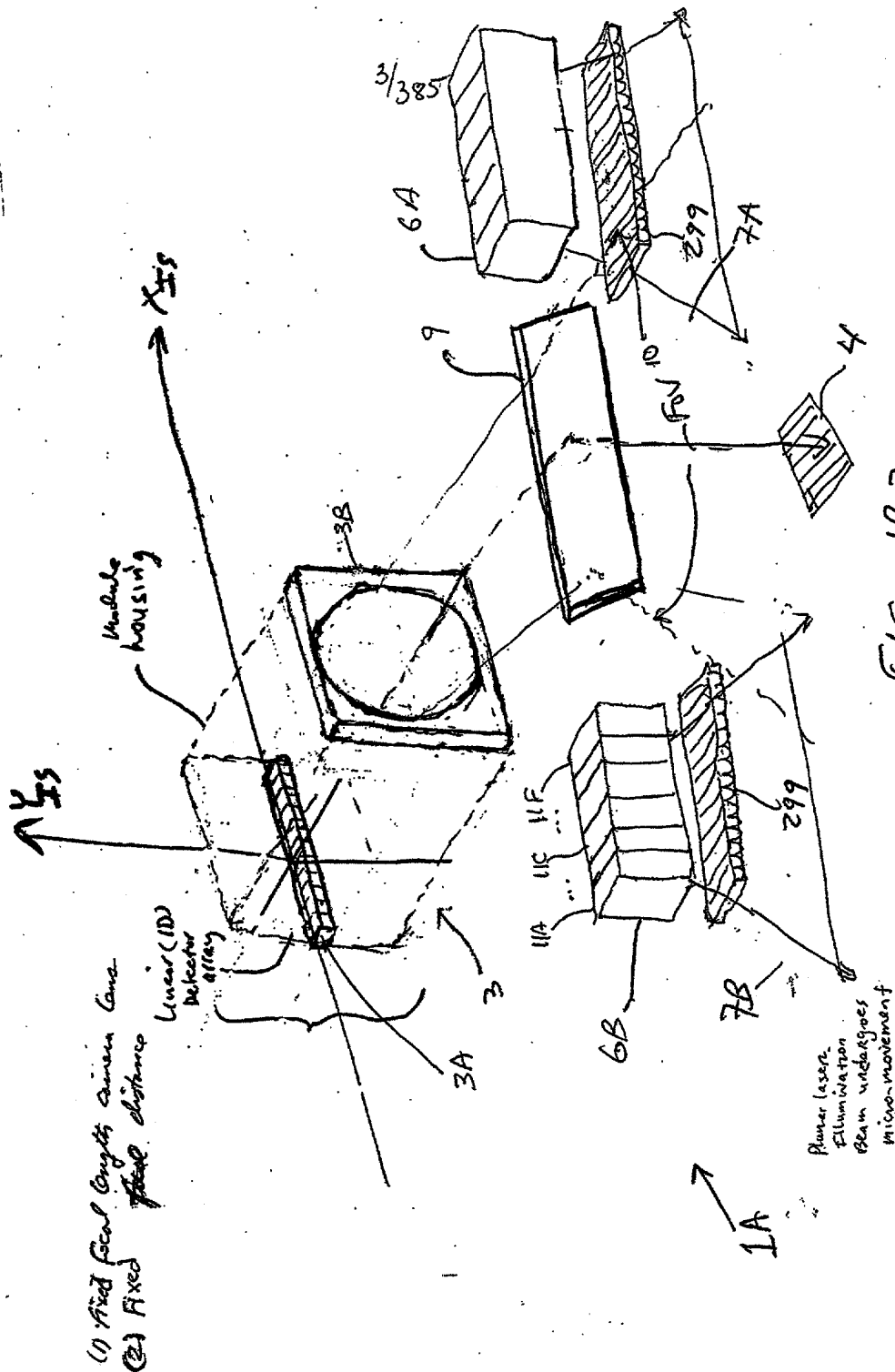
1A

FIG 1B1

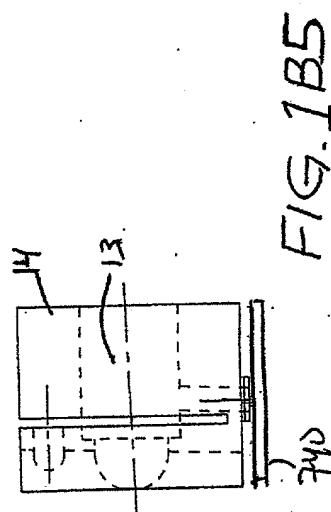
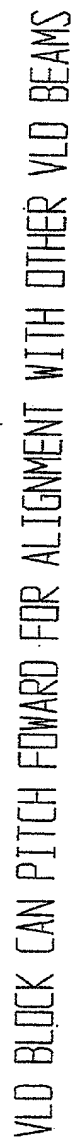
Magnified field of view of  
CCD sensor element on  
object  
width of projected  
laser illumination  
beam on  
object

FIG 1B3

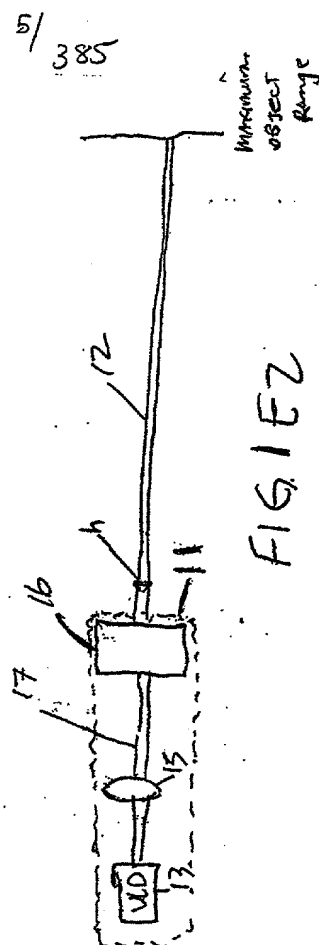
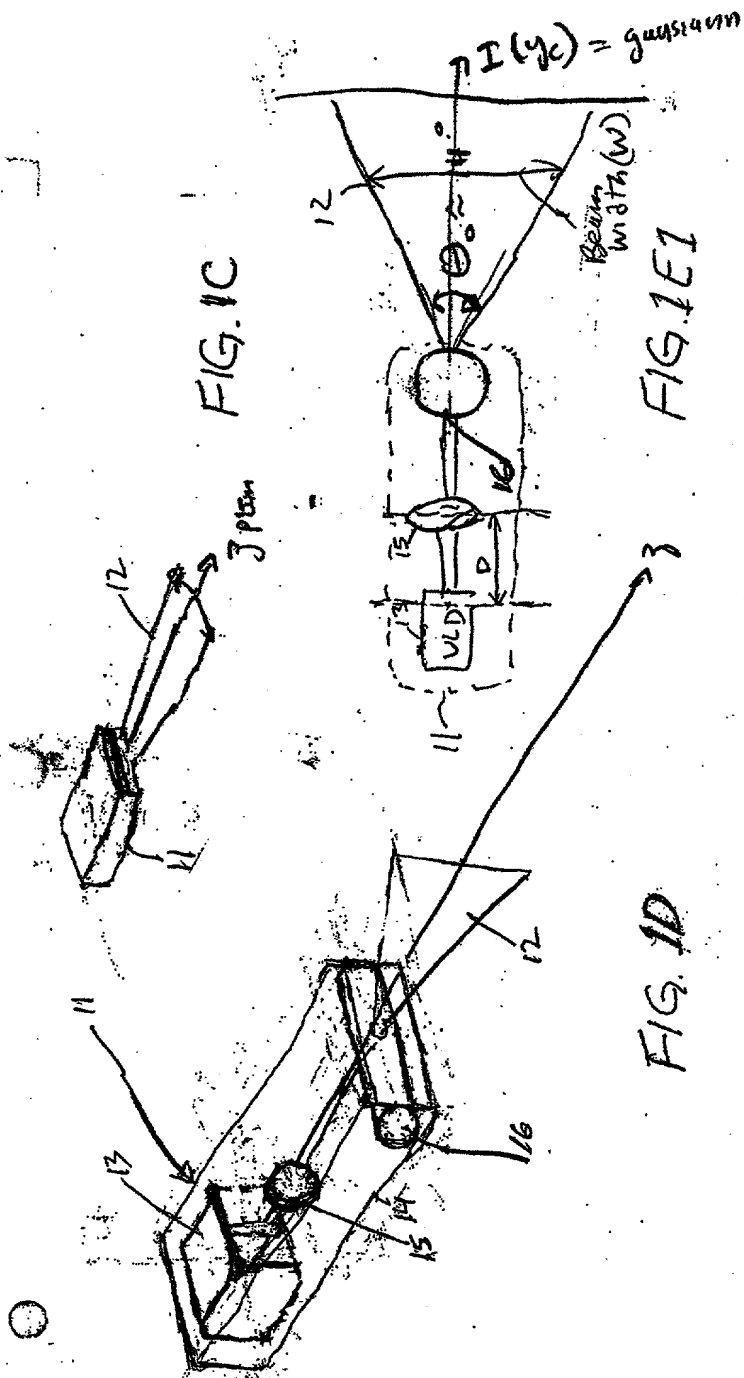
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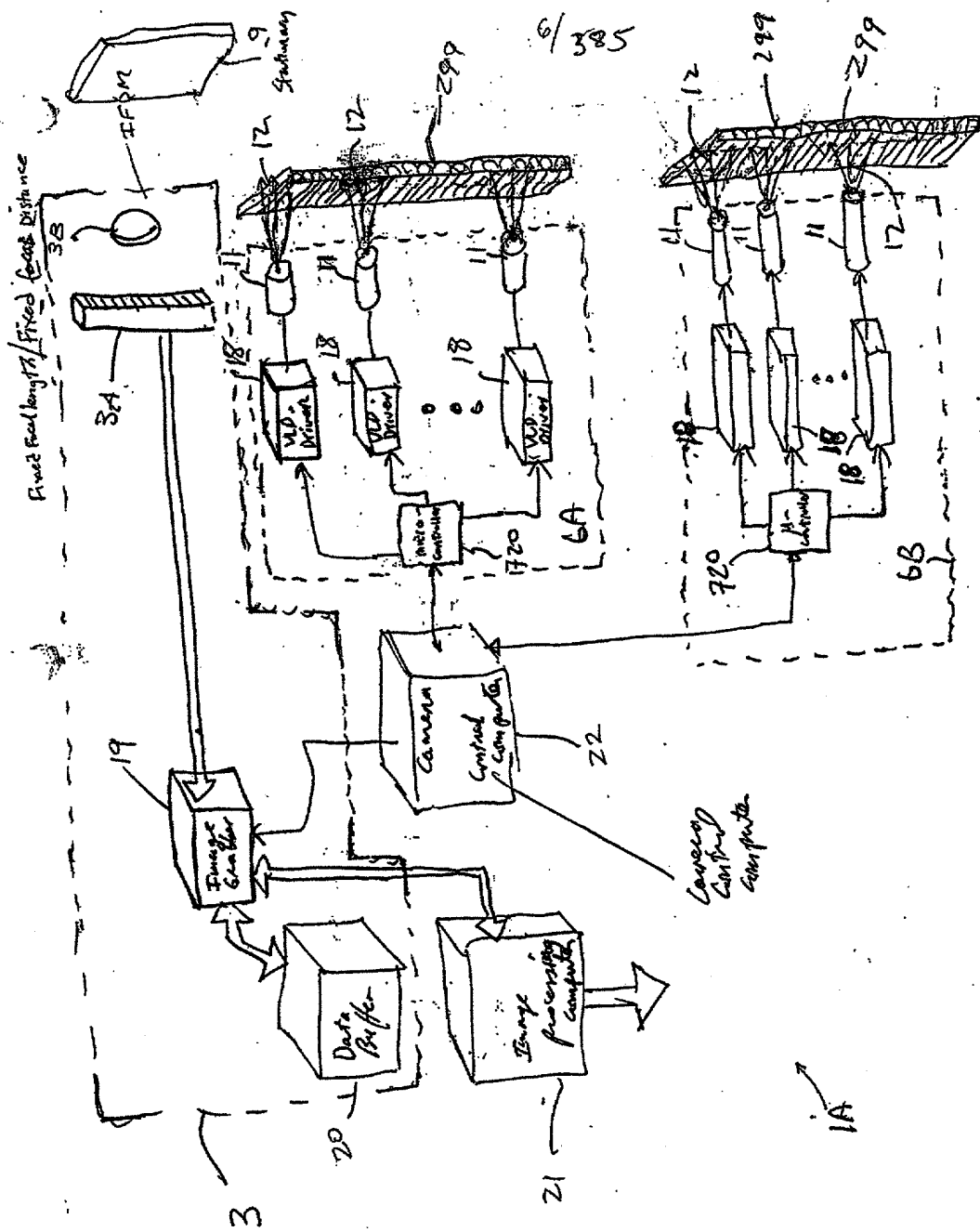


FIG. 1F



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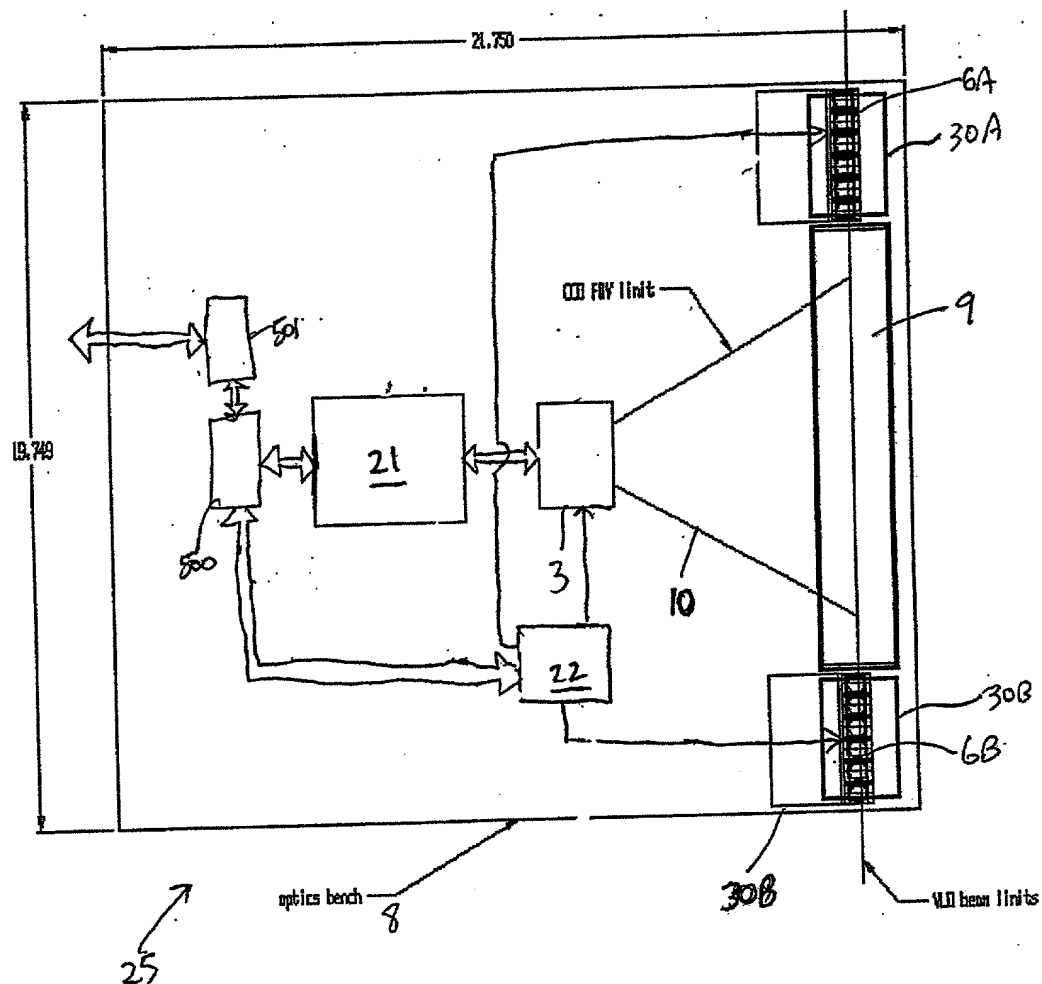


FIG. 1G2

**FOR OFFICIAL USE ONLY**

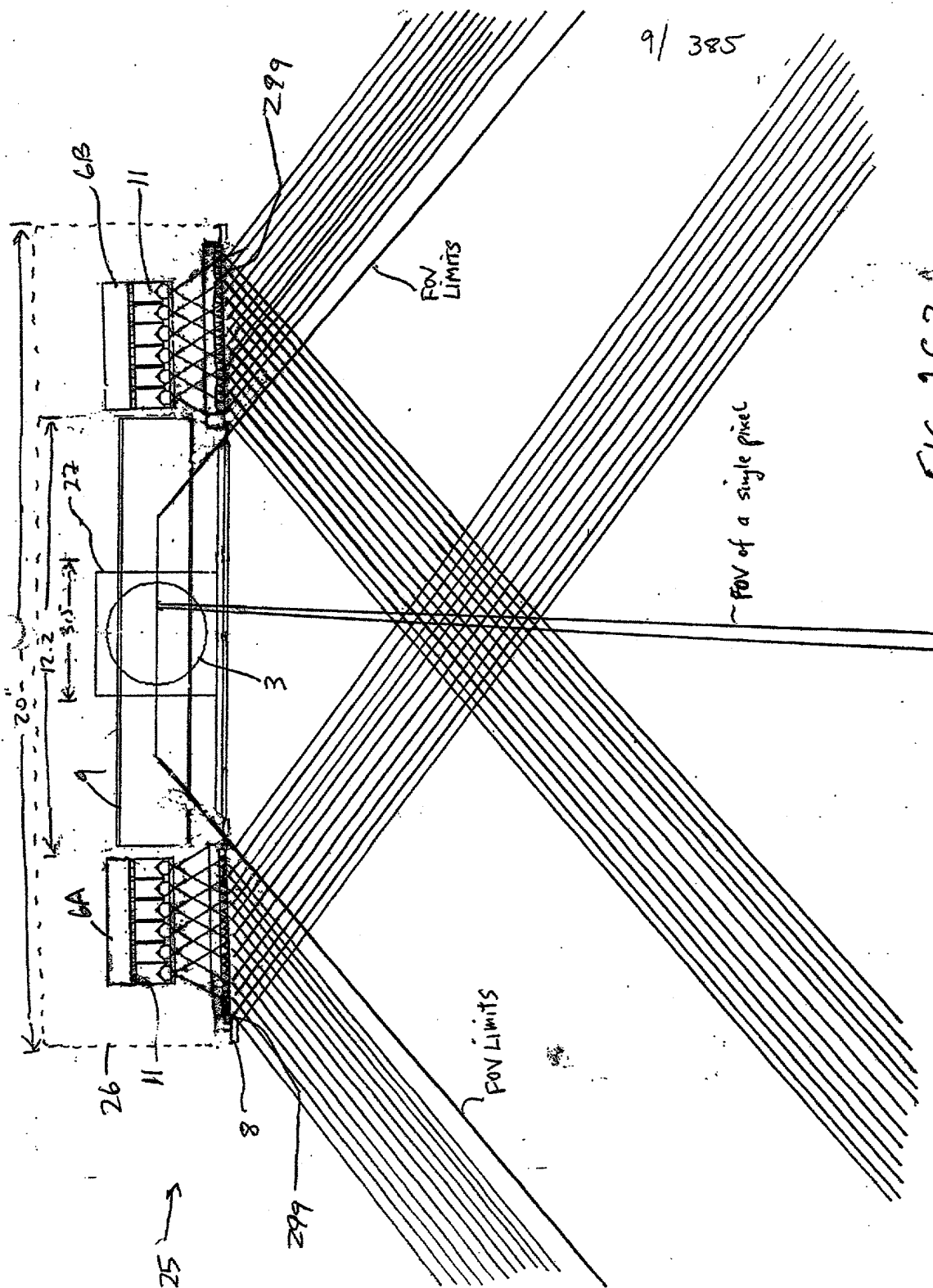


FIG. 1G3

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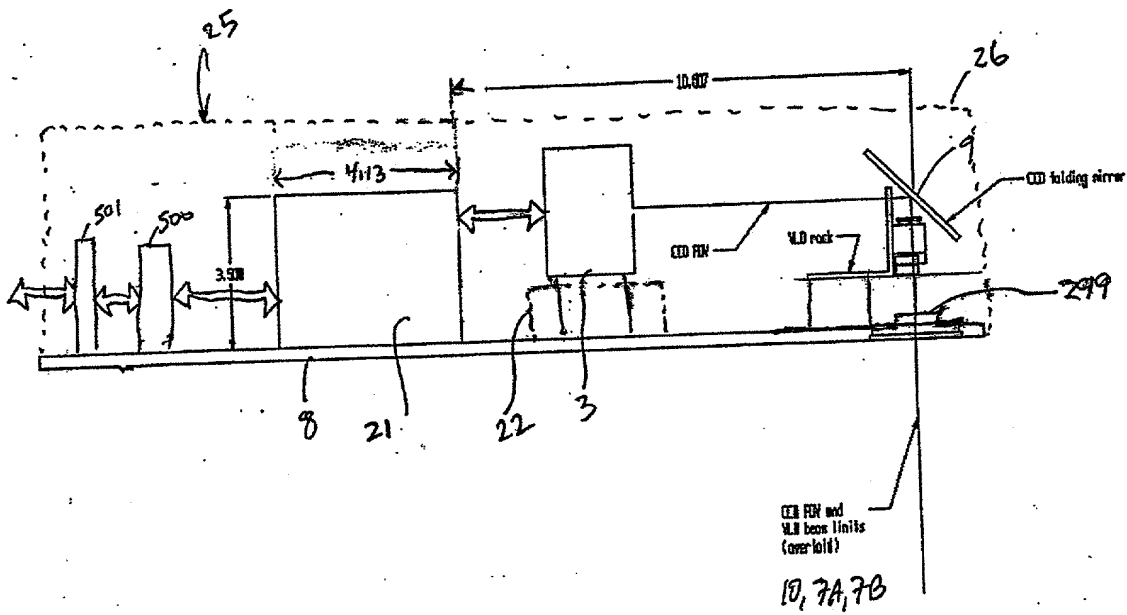
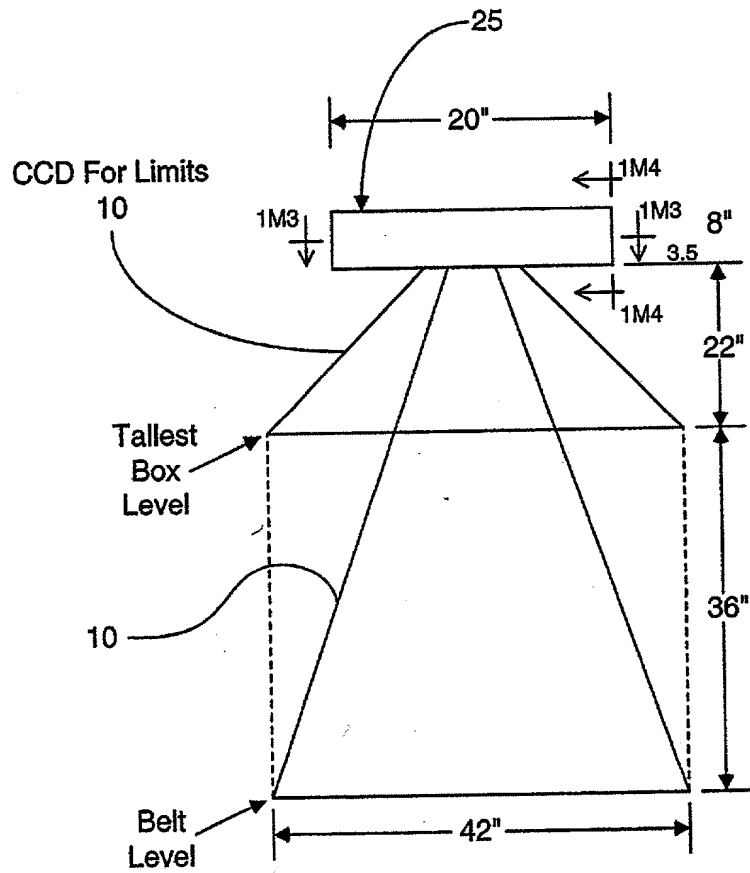


FIG. 164

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\* Fixed Field Of Field

FIG. 1G5

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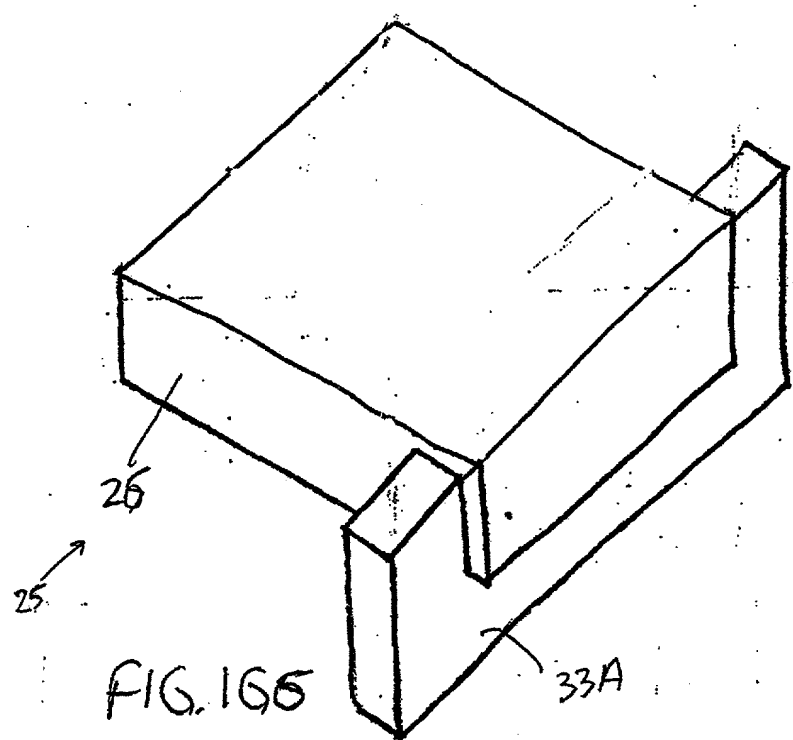


FIG. 165

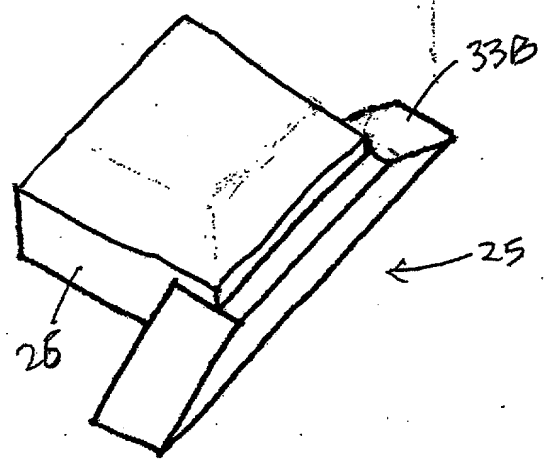


FIG. 167

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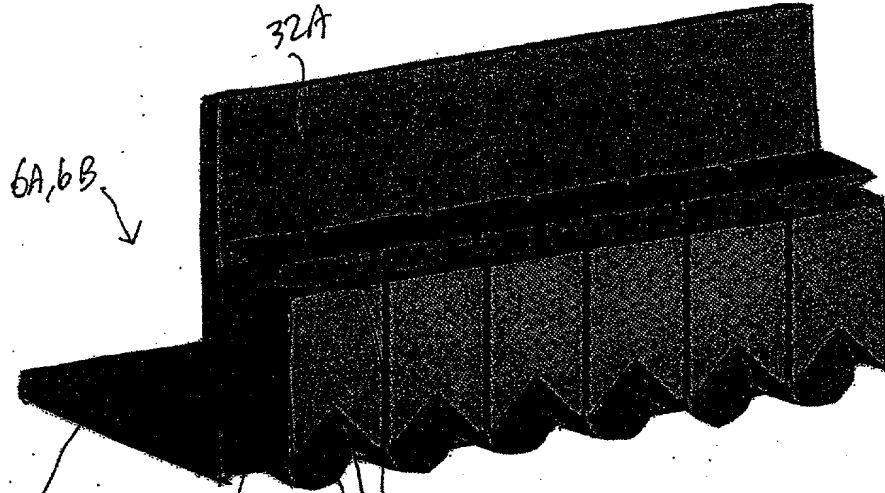


FIG. 1G 8

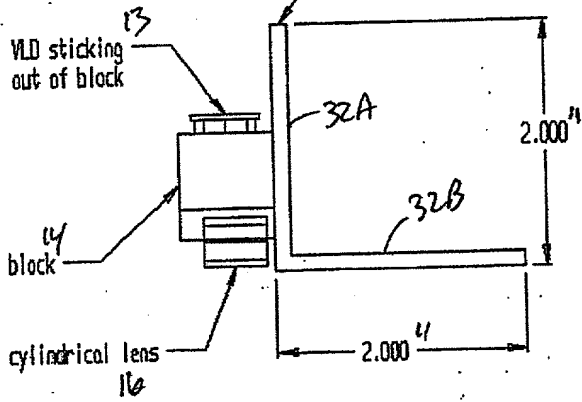


FIG. 1G.9

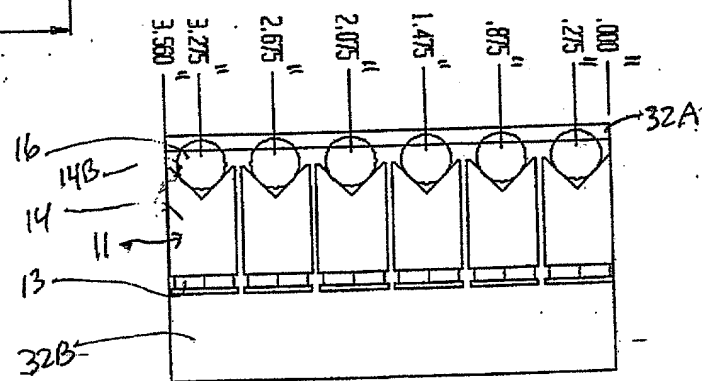


FIG. 1G 10

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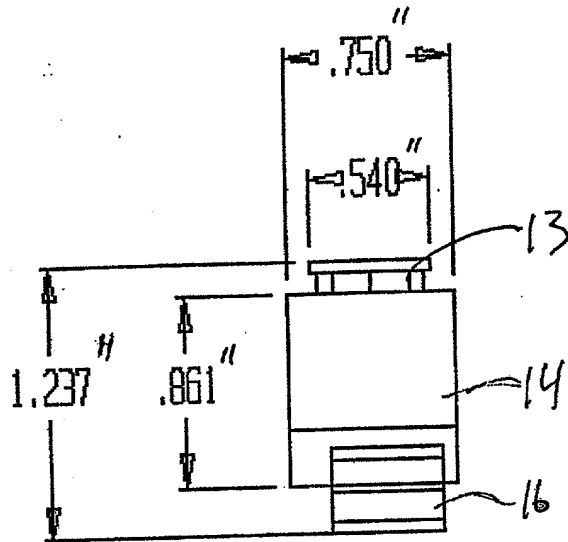


FIG. 1G11

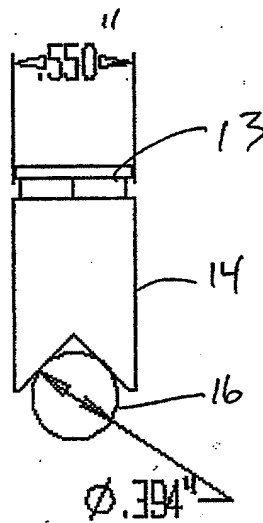


FIG. 1G12

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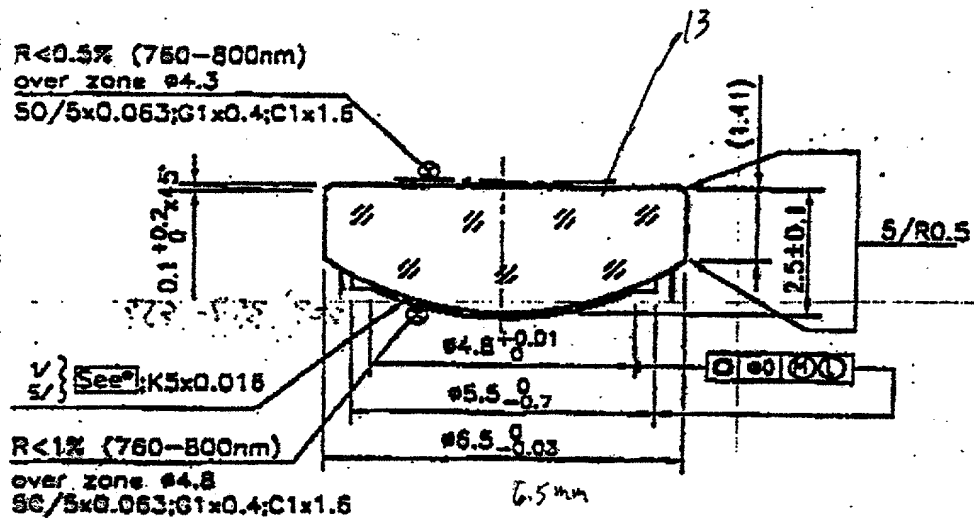


FIG. 1G13

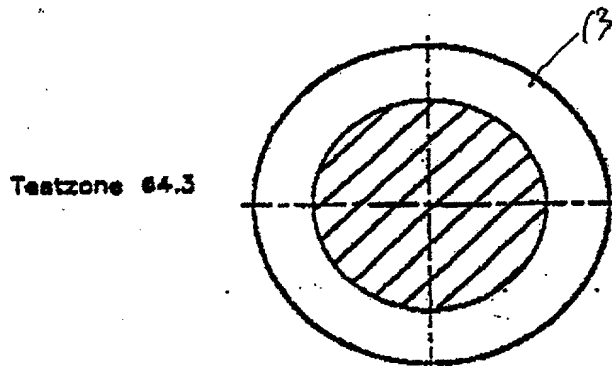


FIG. 1G14

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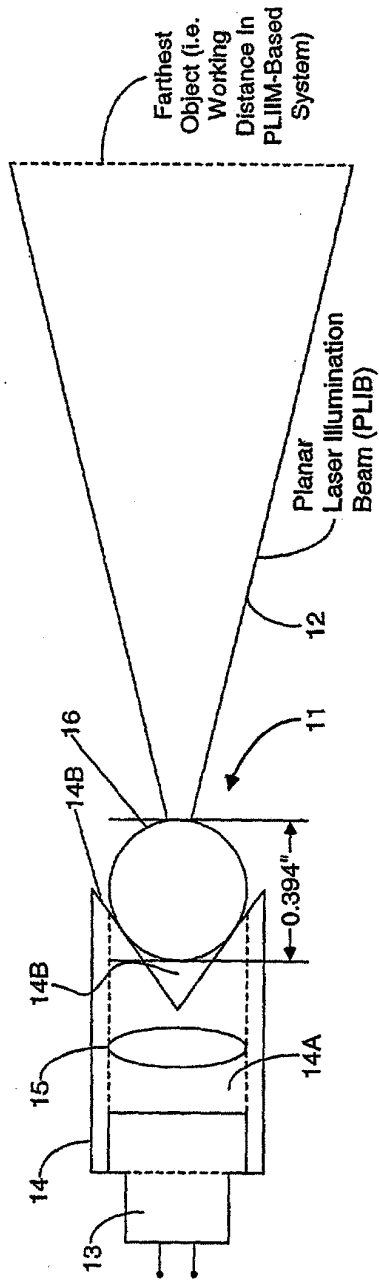


FIG. 1G15A

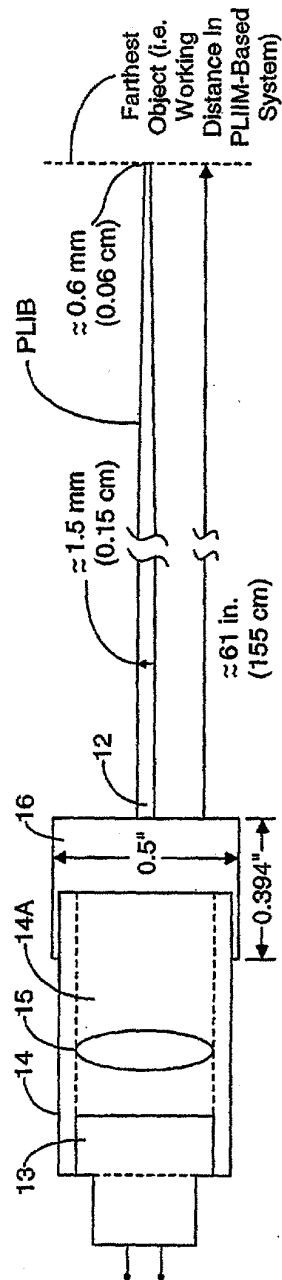
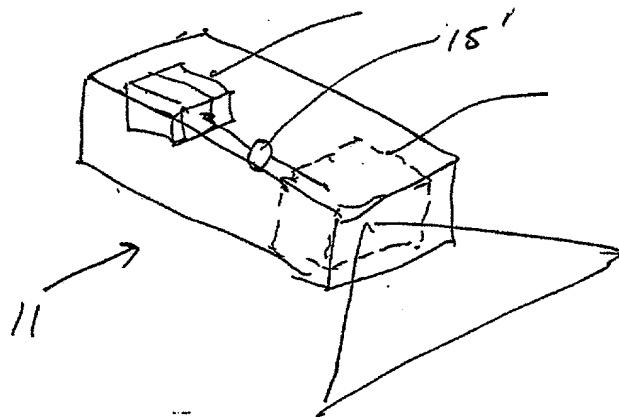
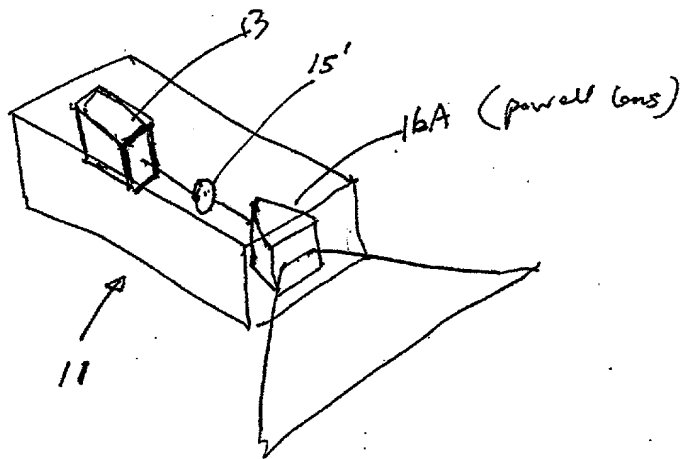


FIG. 1G15B

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PLIM of  
power lens

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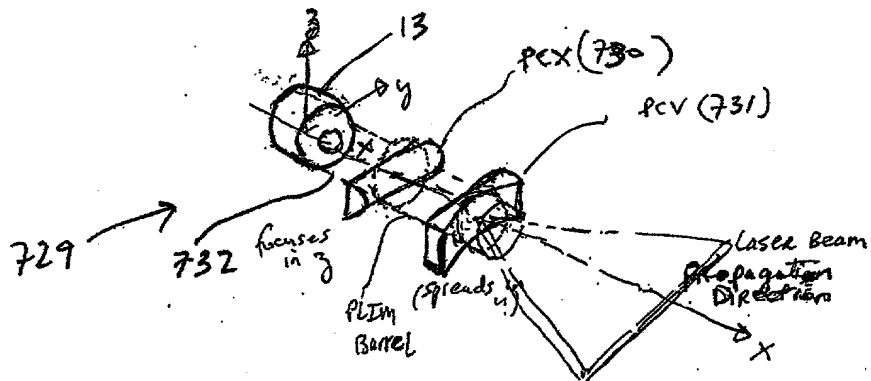


FIG. 16.17A

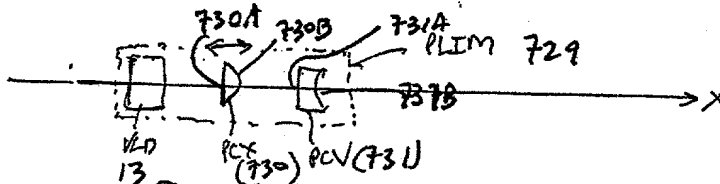


FIG. 16.17B

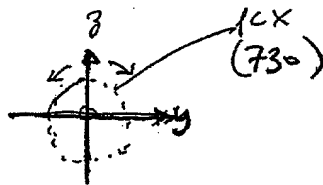


FIG. 16.17C

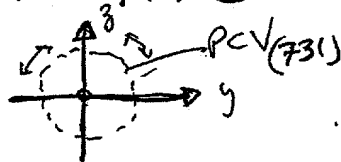


FIG. 16.17D



FIG. 16.17E

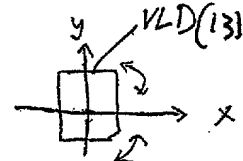


FIG. 16.17F

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FIG. 1H6







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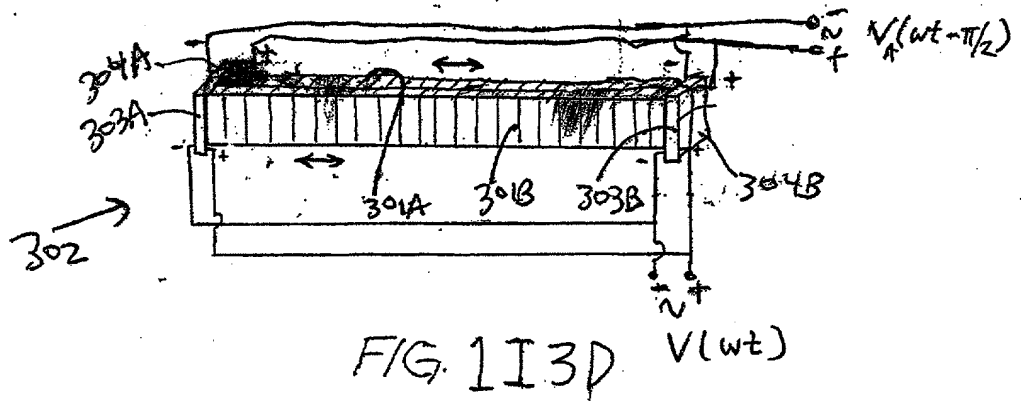
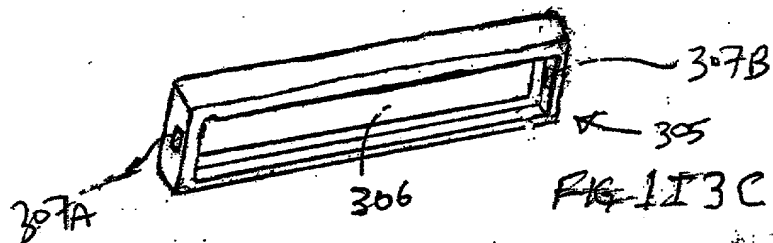
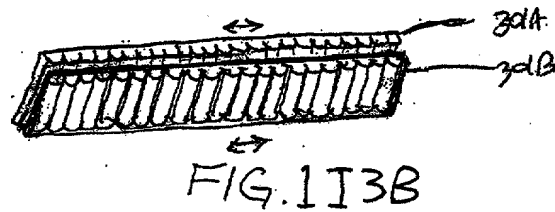
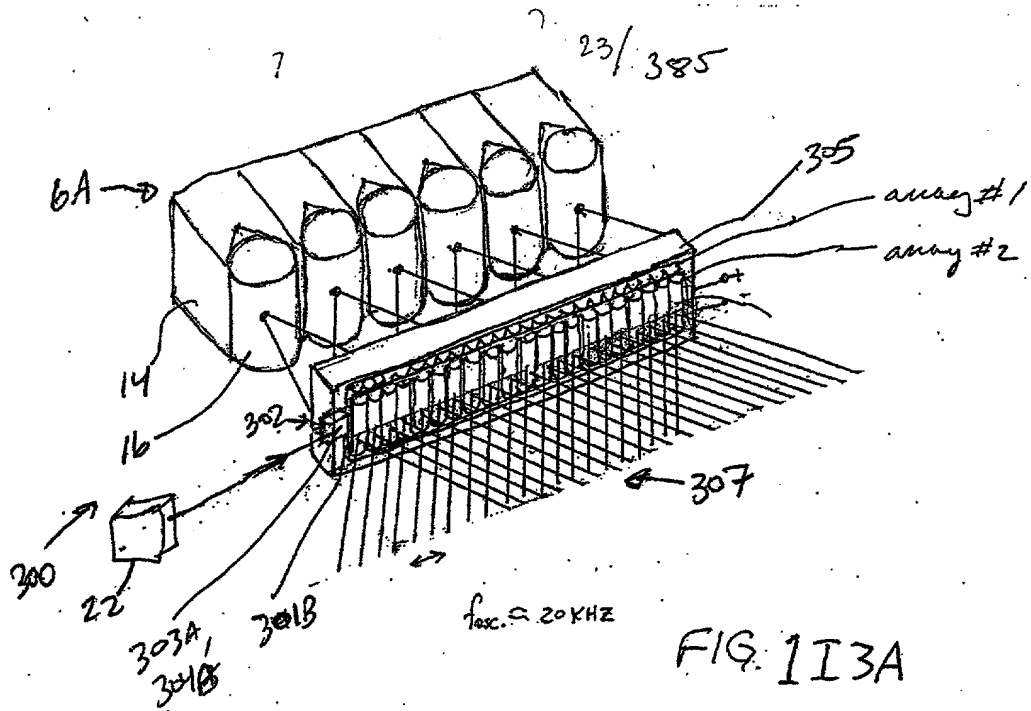
**The First Generalized Speckle-Noise Pattern Reduction Method**  
**Of The Present Invention**

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial phase of the transmitted PLIB along the planar extent thereof according to a spatial phase modulation function (SPMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array.

FIG. 1I2B

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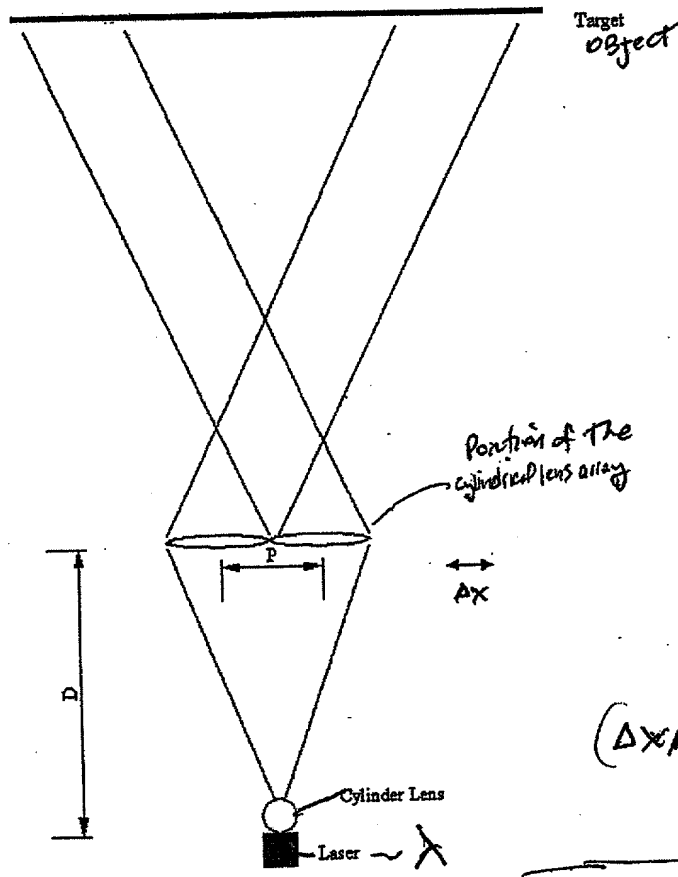


Figure 1

$$(\Delta x / D) P = \lambda$$

$$\Delta x \geq \frac{\lambda \cdot D}{P}$$

FIG. 1I3E

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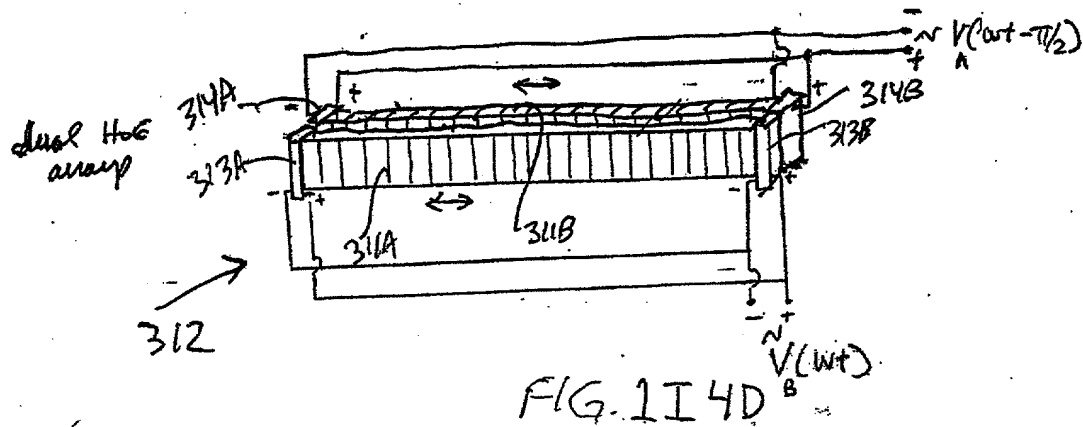
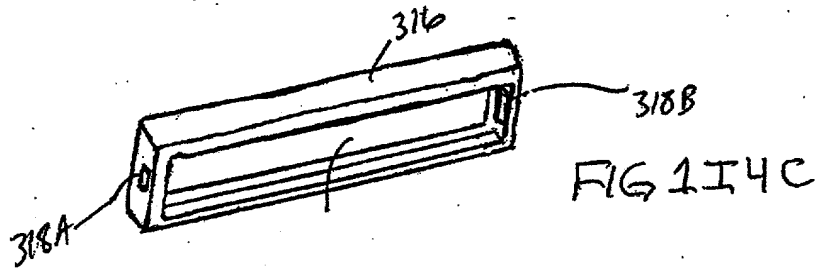
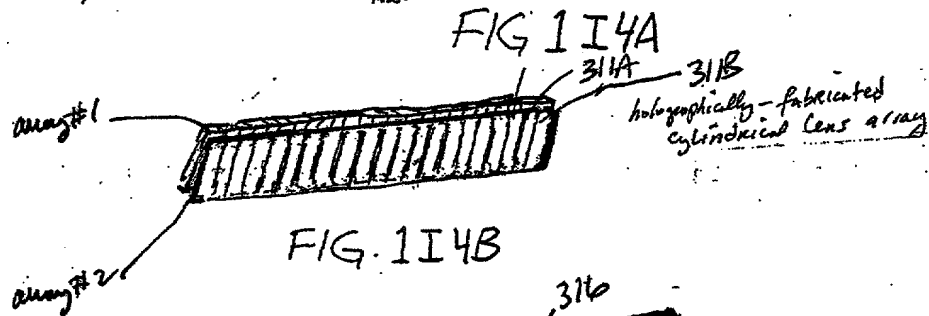
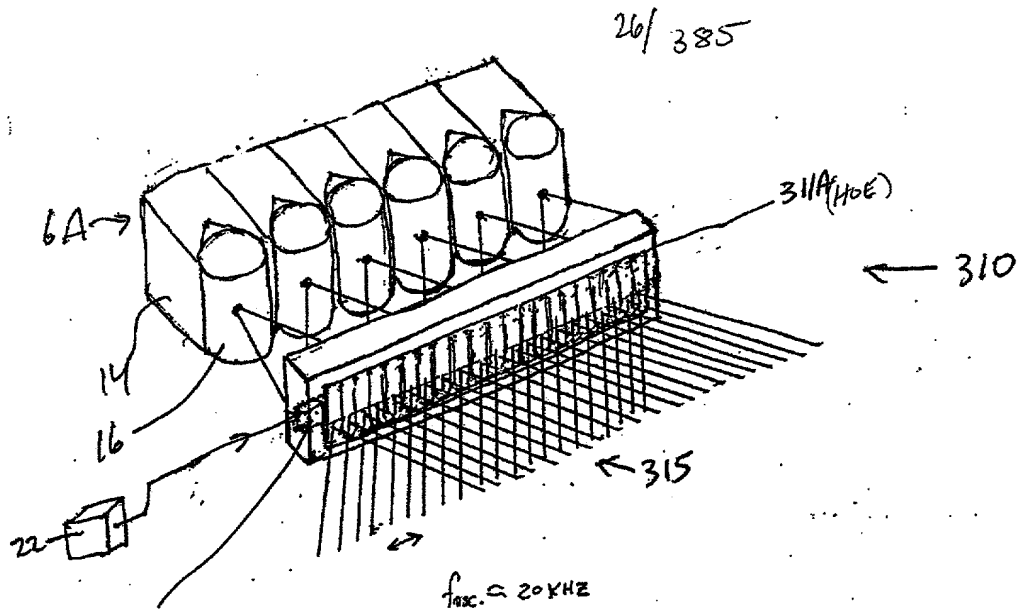
FIG. 1I3F



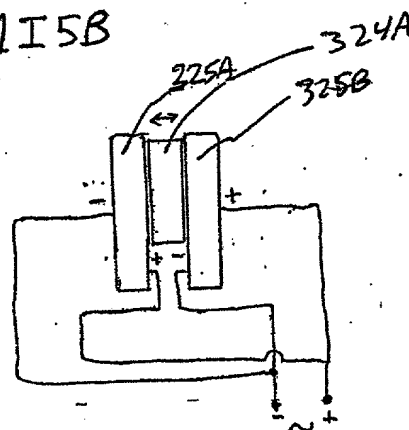
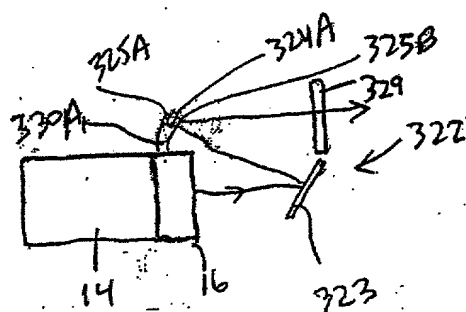
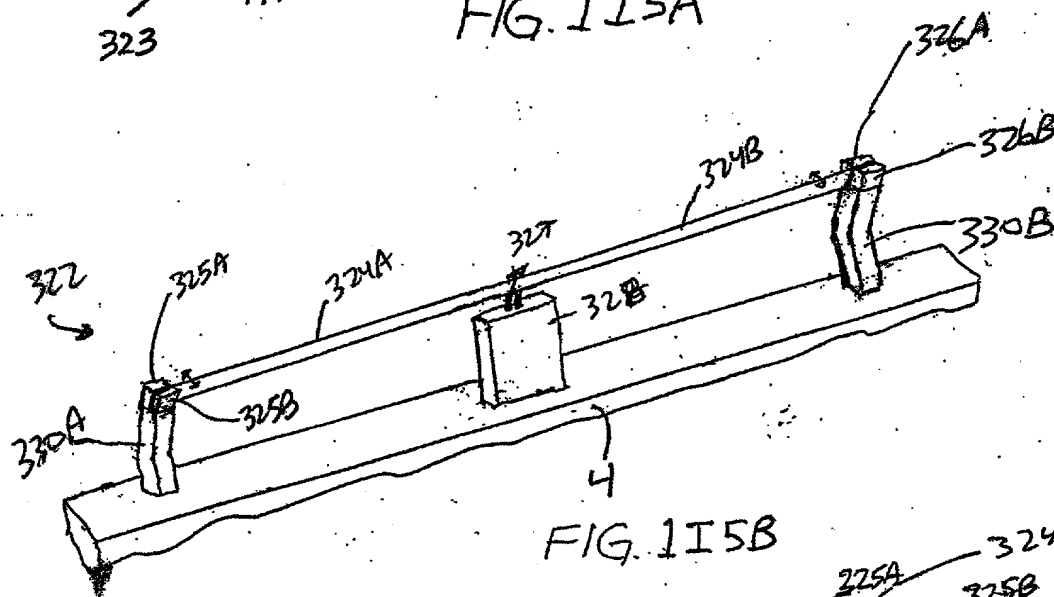
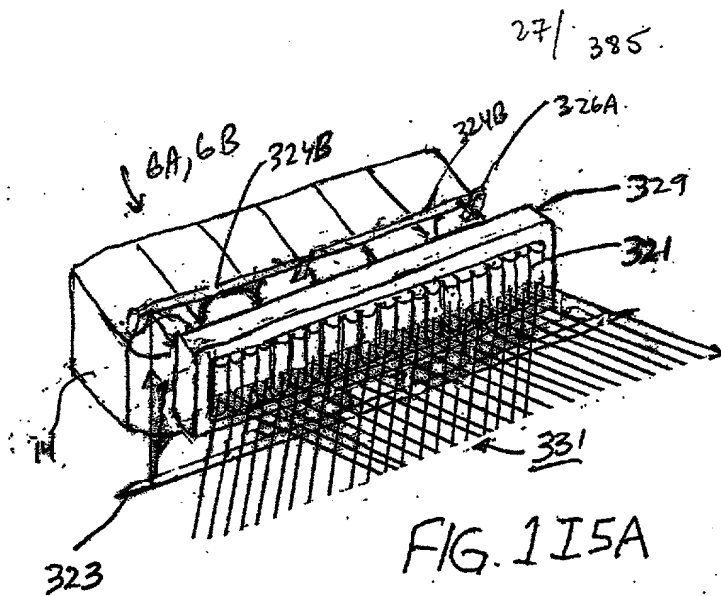
FIG 1I3G

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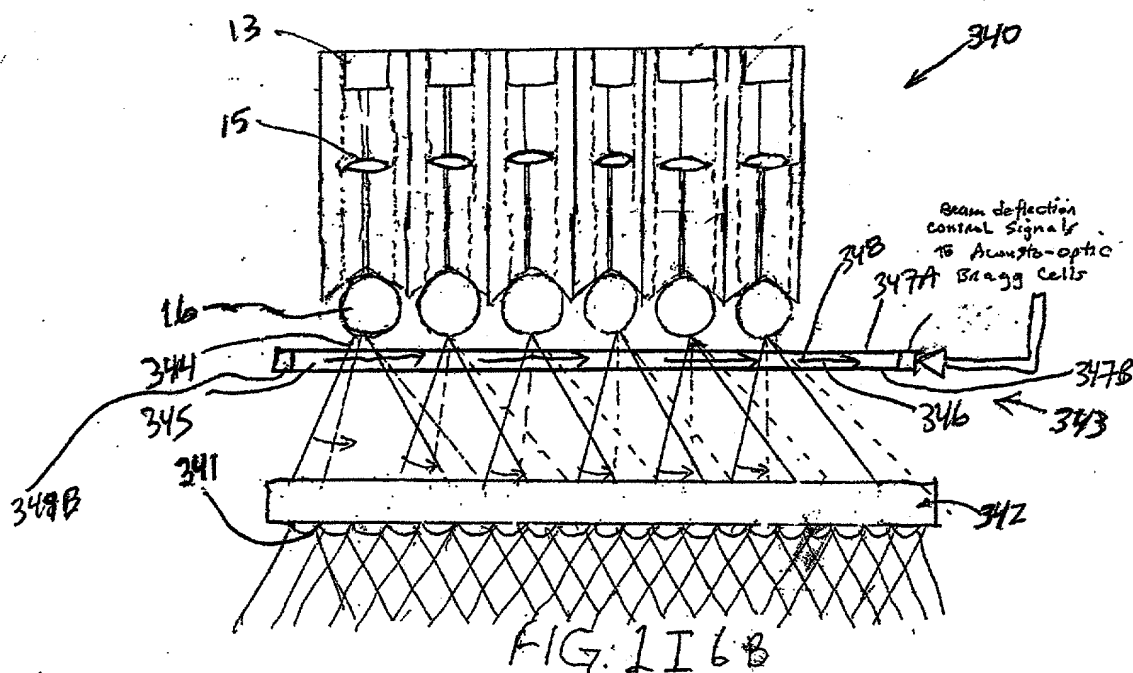
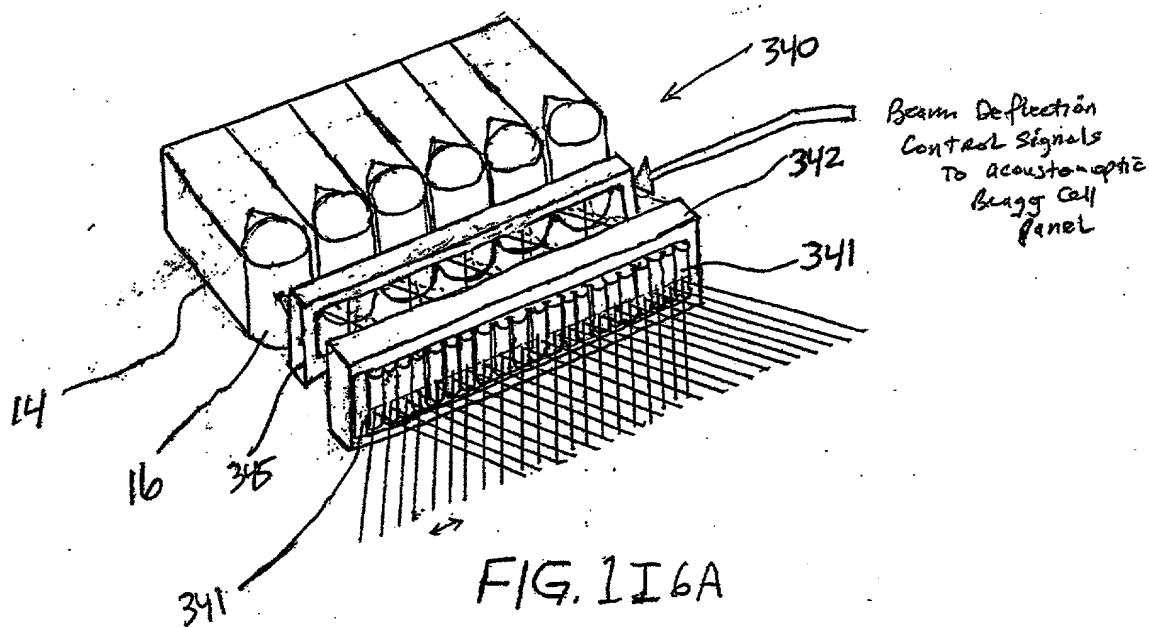
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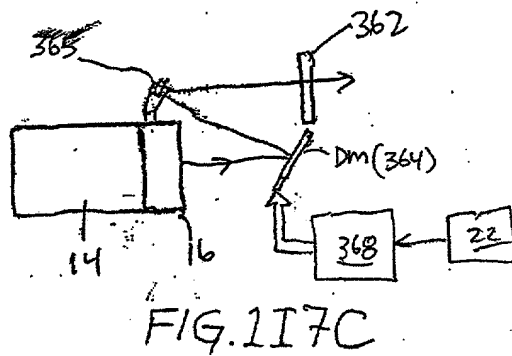
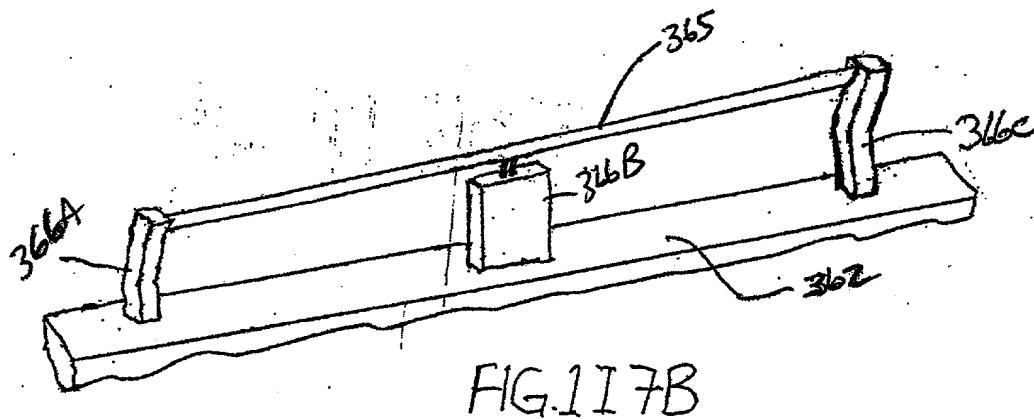
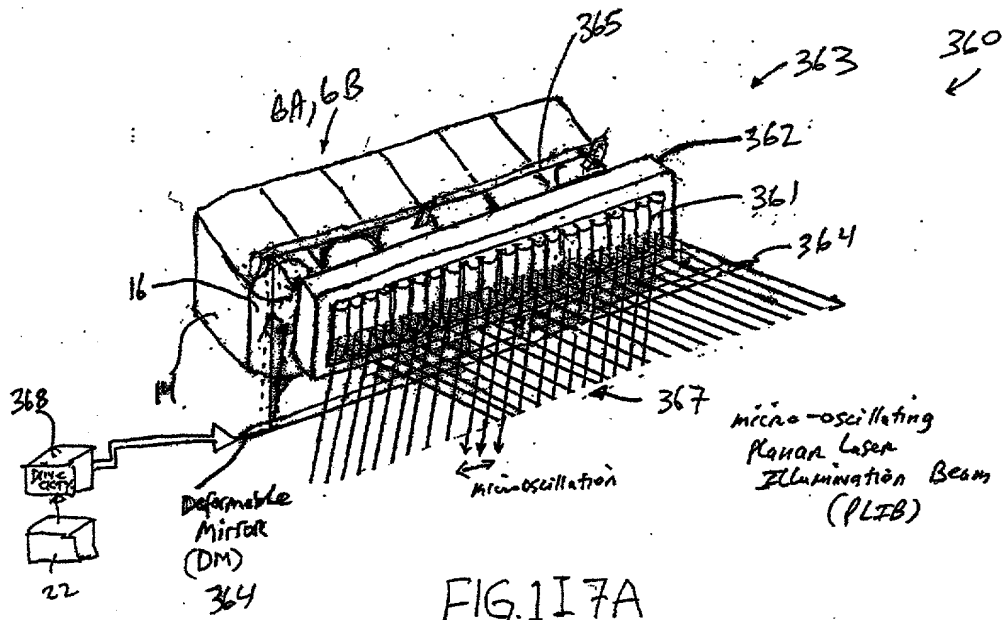


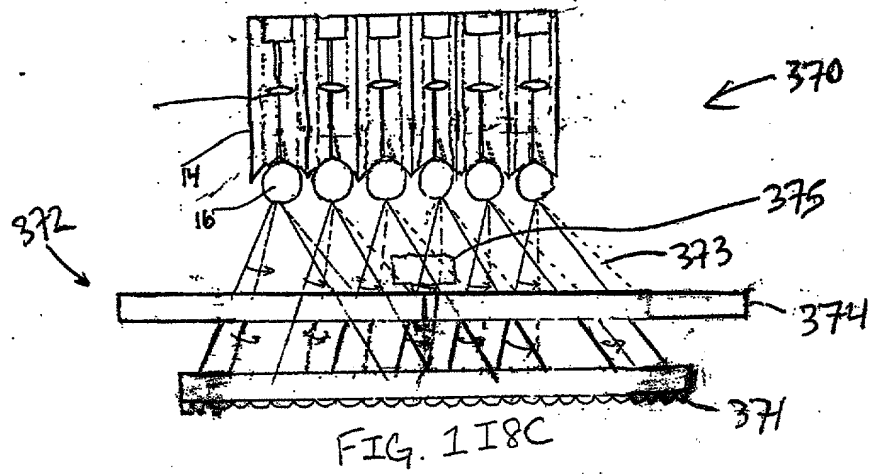
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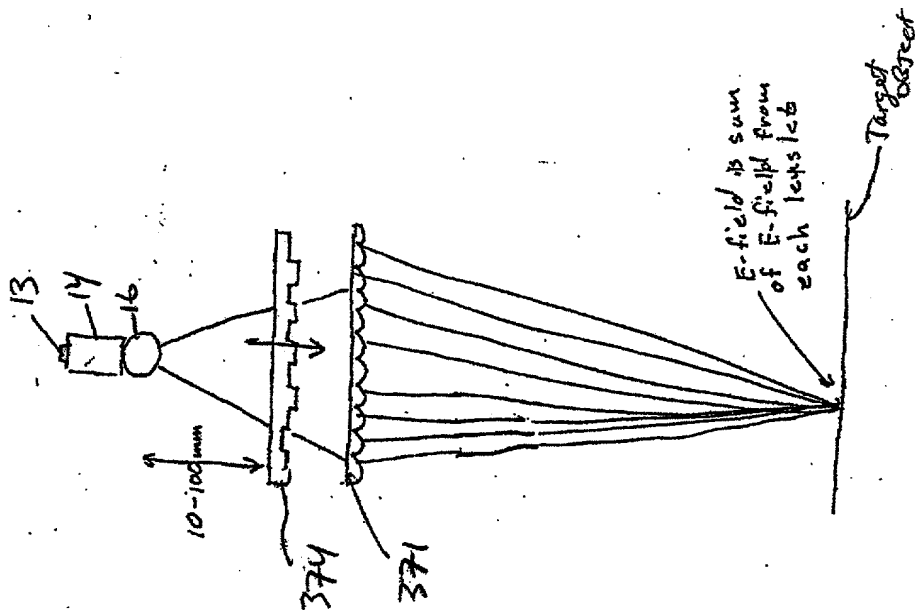


FIG 1I8E

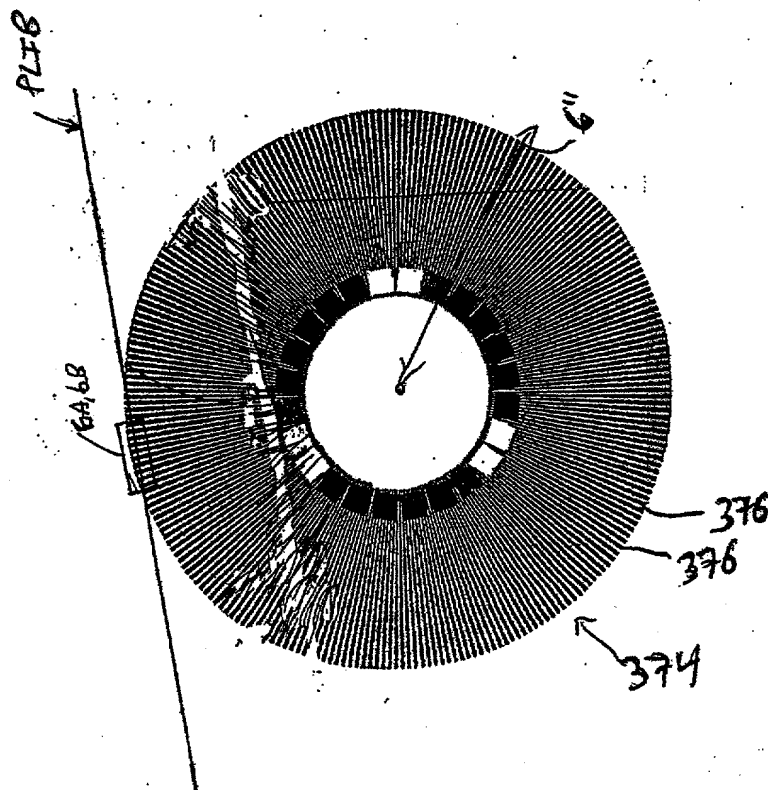


FIG 1I8D

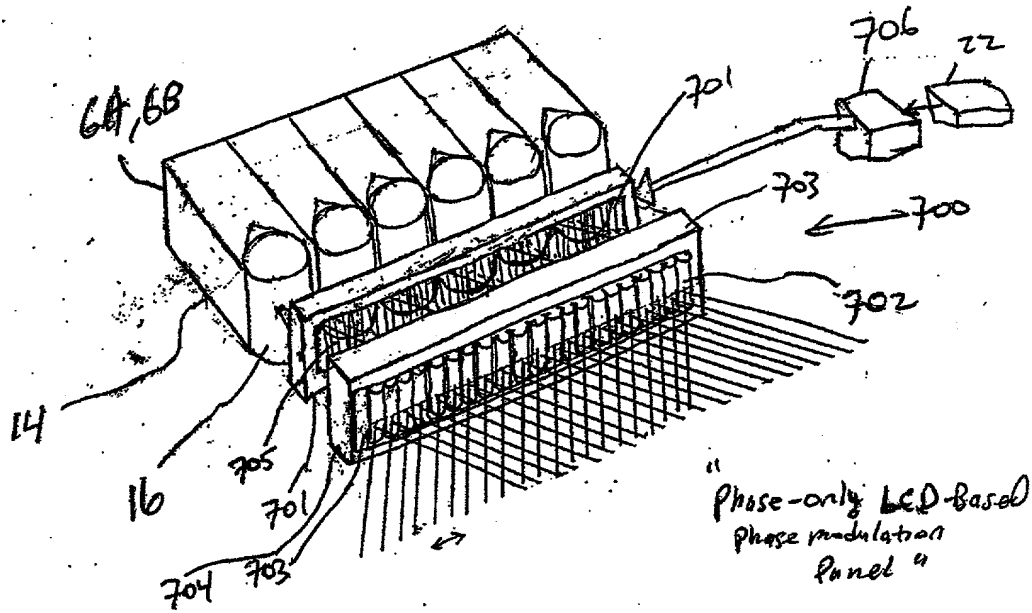


FIG. 1I8F

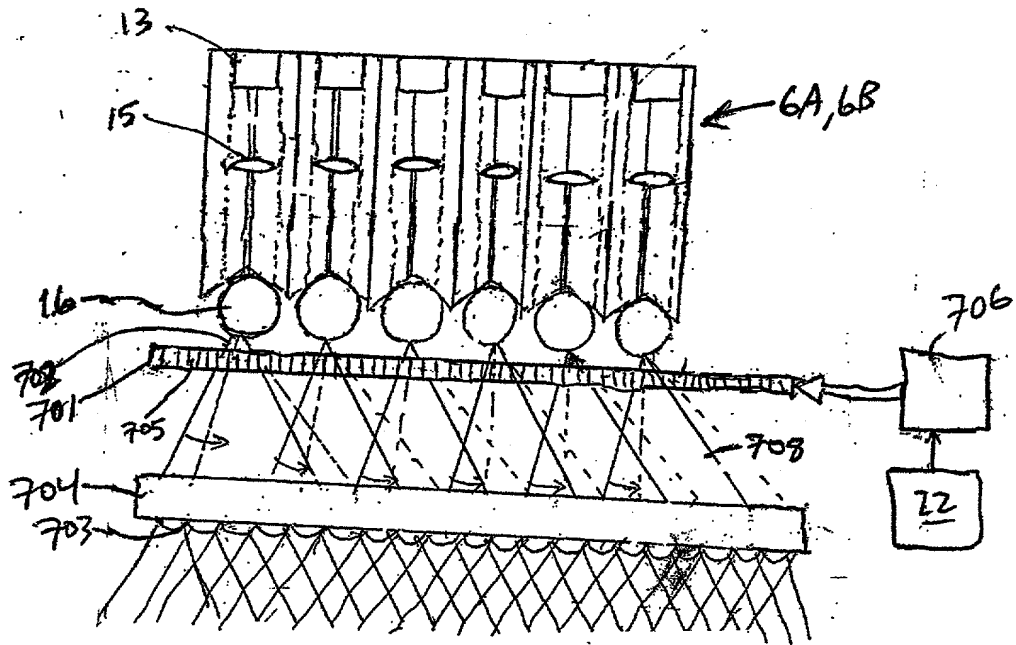


FIG. 1I8G

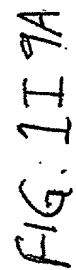
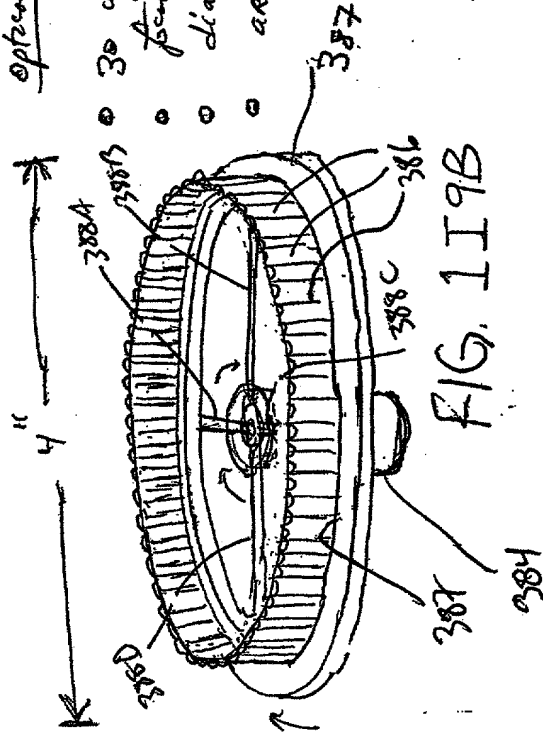


FIG. 1I 9A

Optical specifications:

- 30 cylindrical lens (lens) per linear inch
- focal length  $\approx 2.0$  millimeters
- diameter of cylindrical carousel  $\approx 4$  inches
- acrylic material



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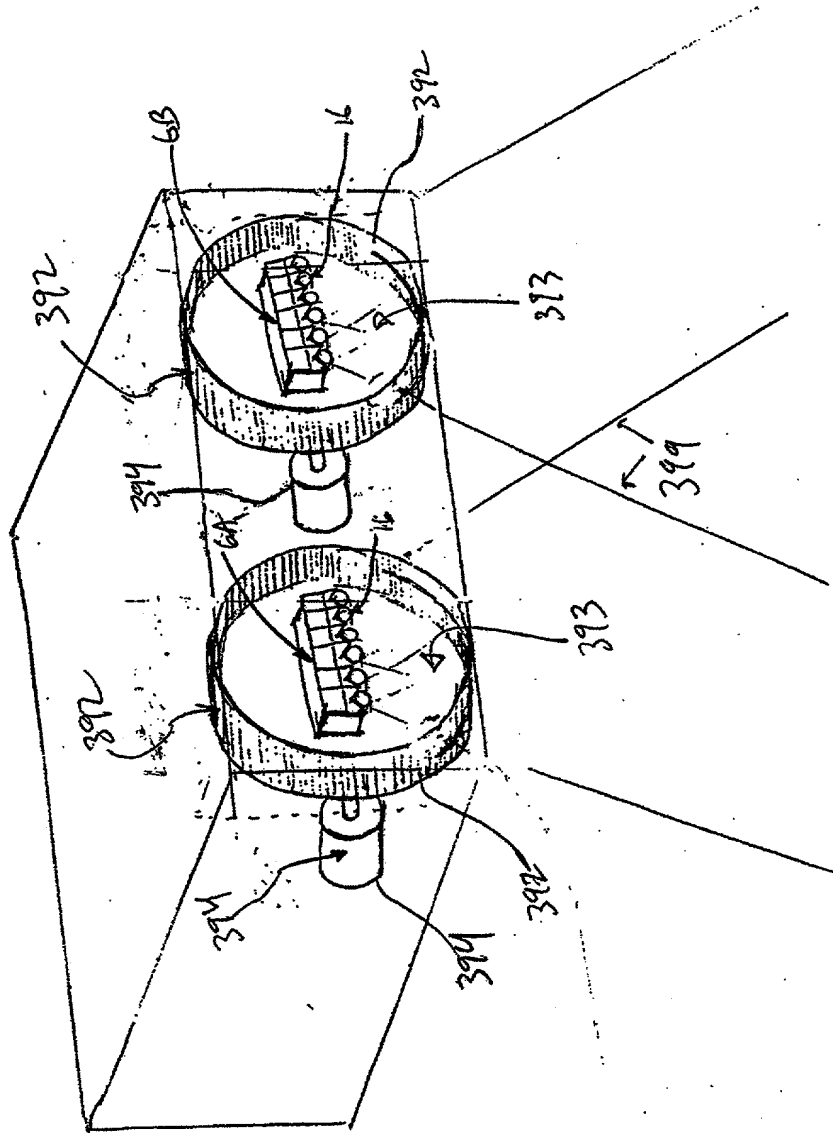
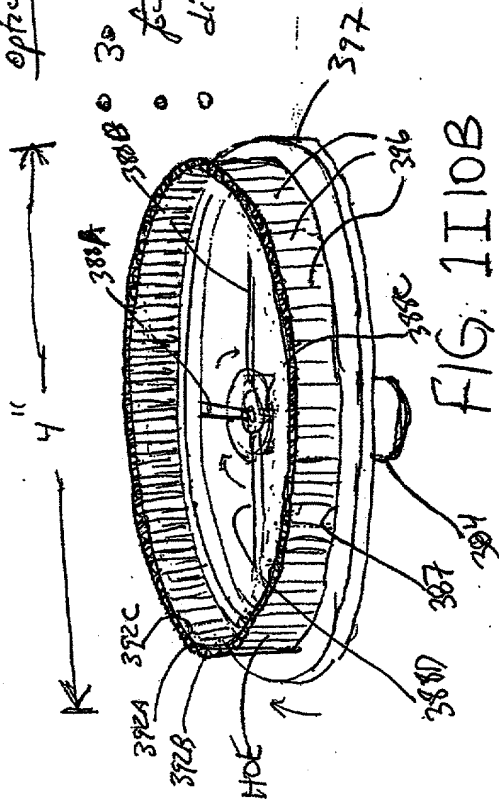


FIG. 1110A

Optical specifications:

- 30 cylindrical lens (lines) per linear inch
- focal length  $\approx$  2.0 millimeters
- diameter of cylindrical carousel  $\approx$  1/4 inches





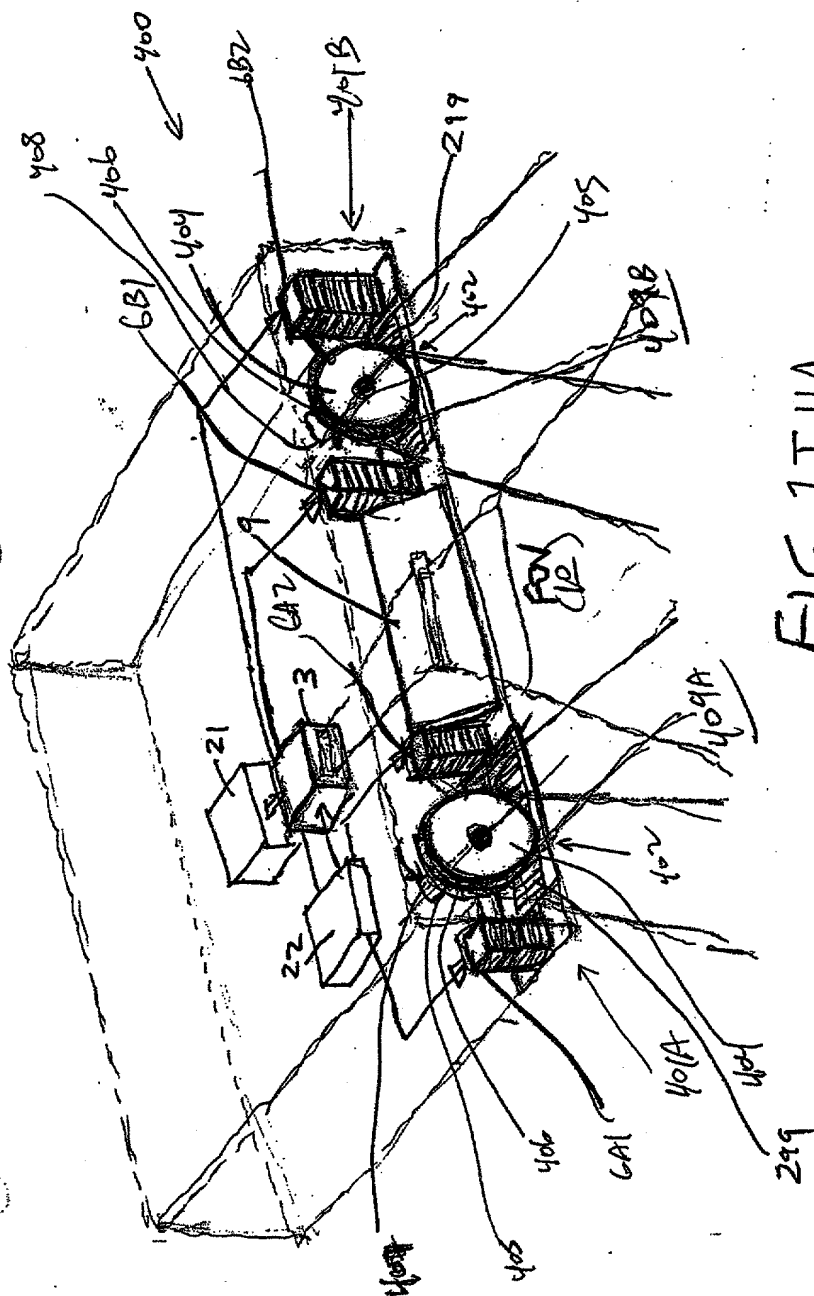
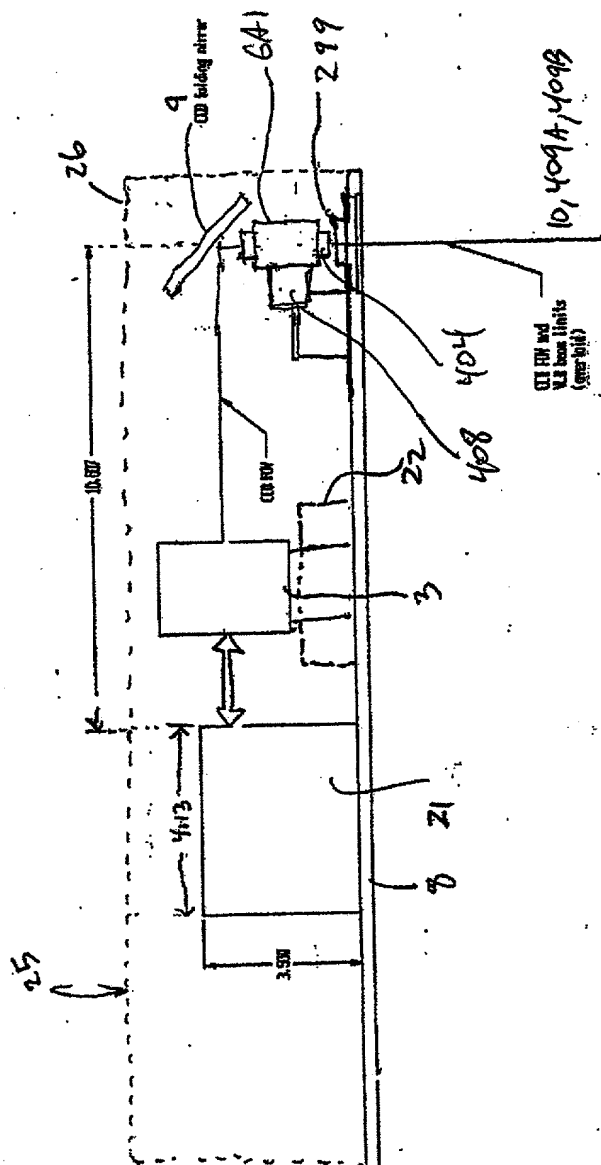
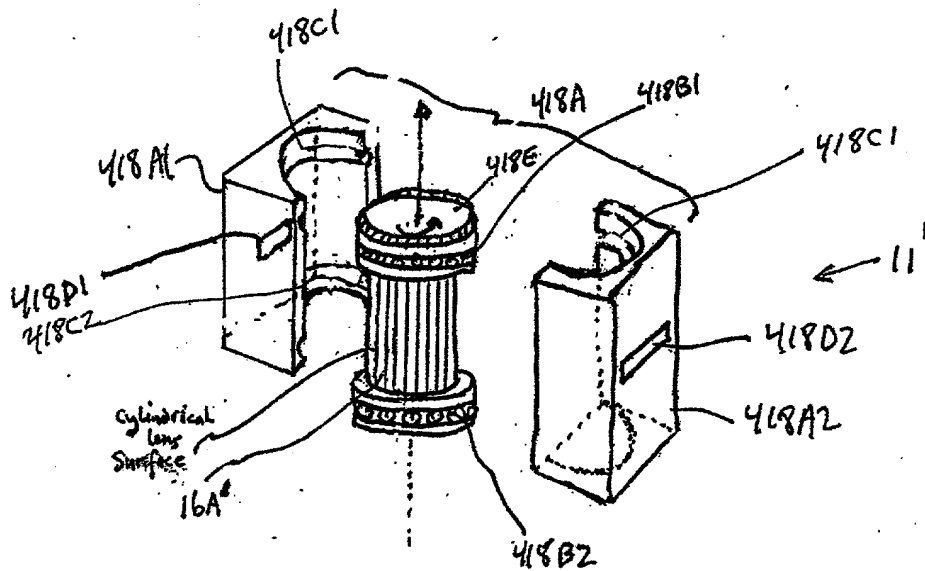
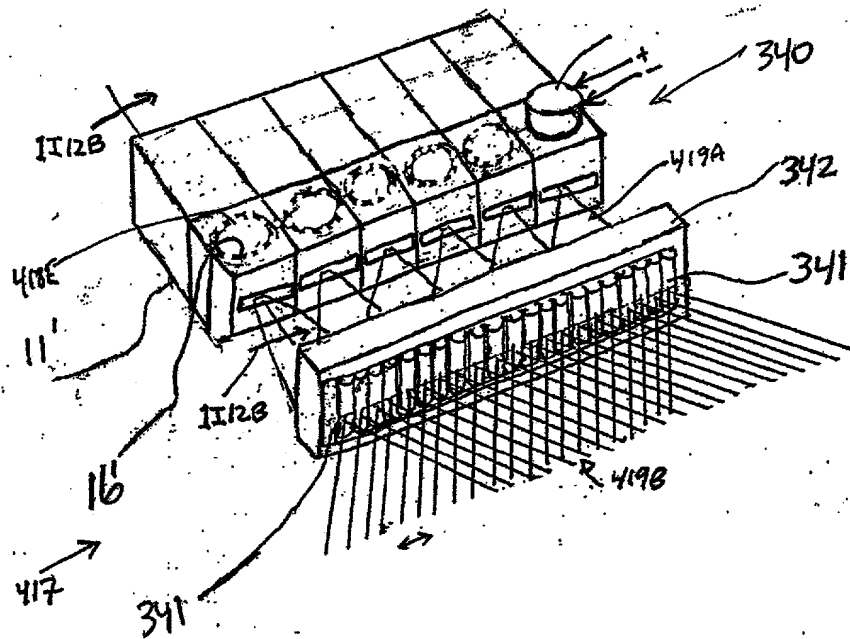


FIG. 1I11A



**INVESTIGATION OF THE EFFECTS OF**





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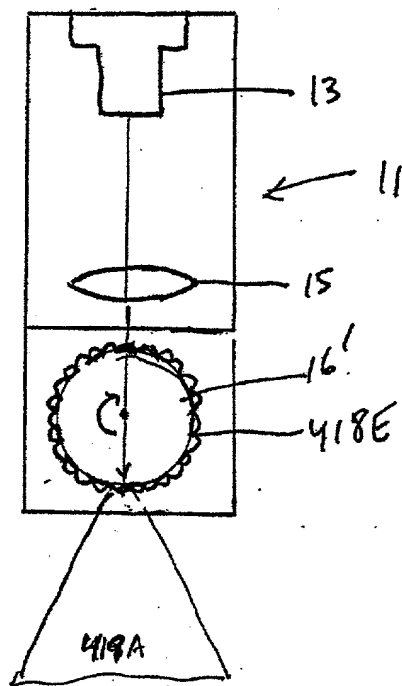


FIG. 1I12C

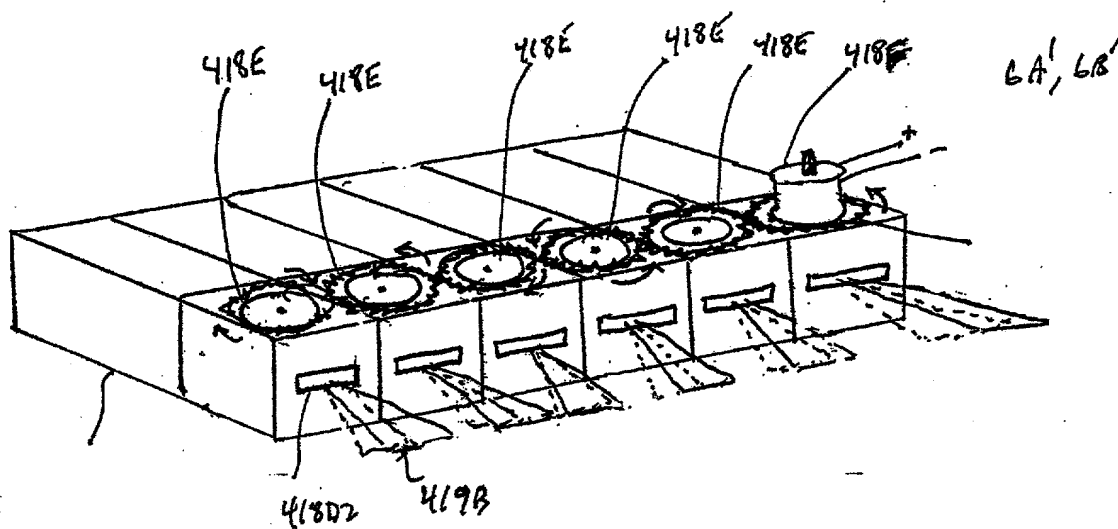


FIG. 1I12D

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Second Generalized Method of  
Reducing Spackle-Noise Patterns  
at Image Detection Array  
of the FFD Subsystem (3)

(TIME)

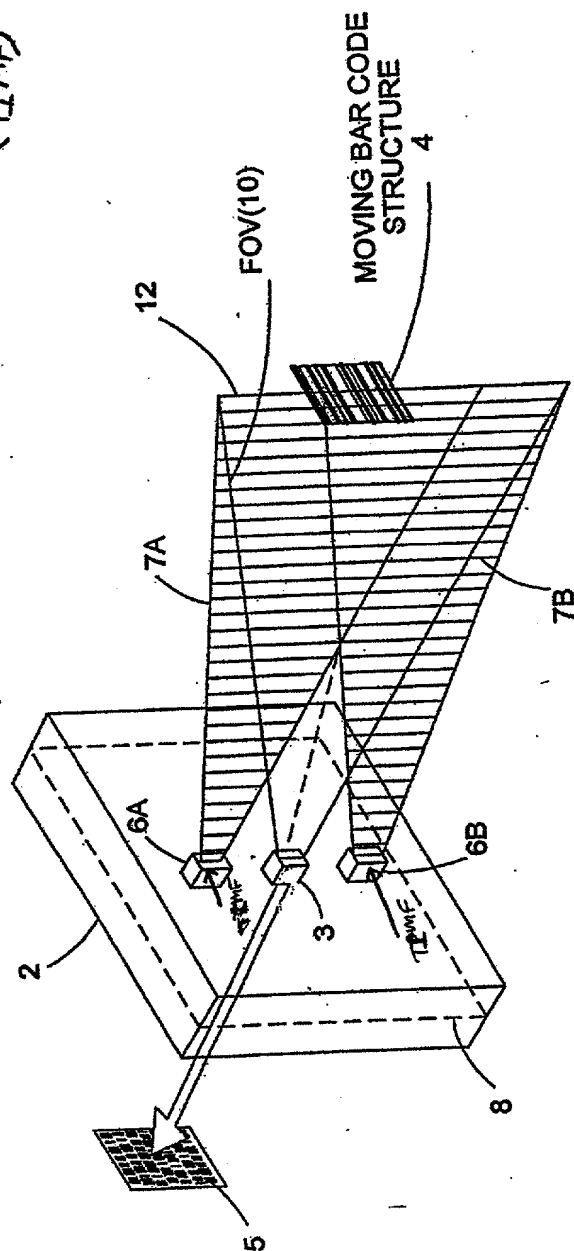


FIG. 11B

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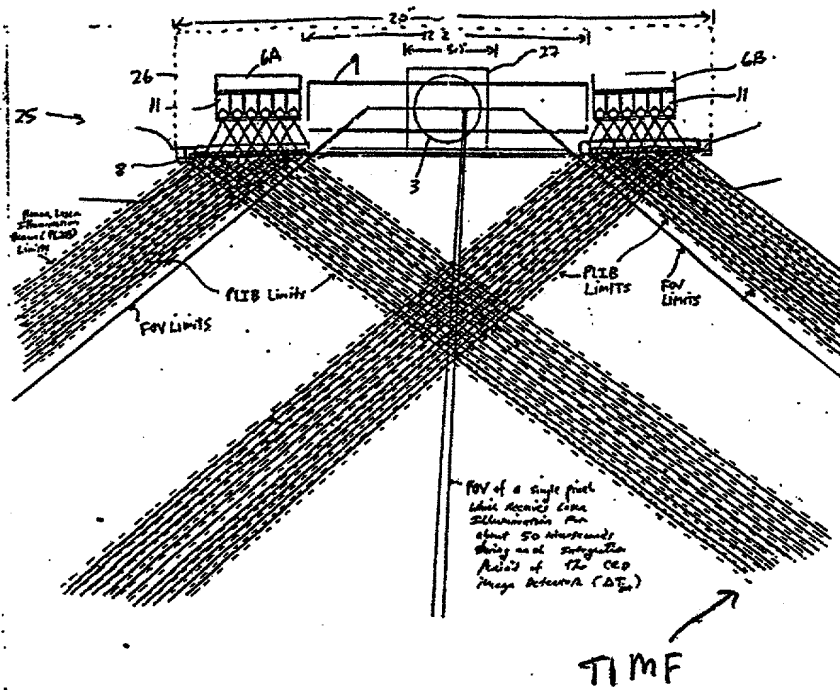


FIG. 1 I 13A

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**The Second Generalized Speckle-Noise Pattern Reduction Method**  
**Of The Present Invention**

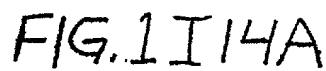
Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal intensity of the transmitted PLIB along the planar extent thereof according to a temporal intensity modulation function (TIME) so as to

produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce power of the speckle-noise pattern observed at the image detection array.

FIG. 1I/3B





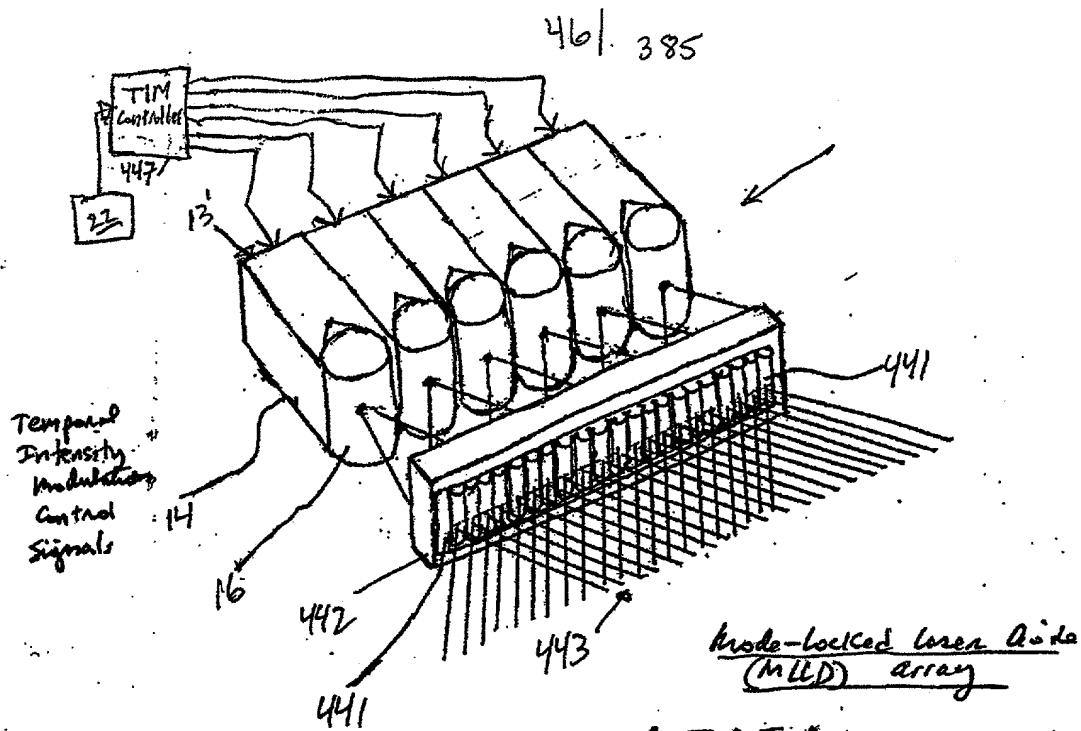


FIG. 1I15A

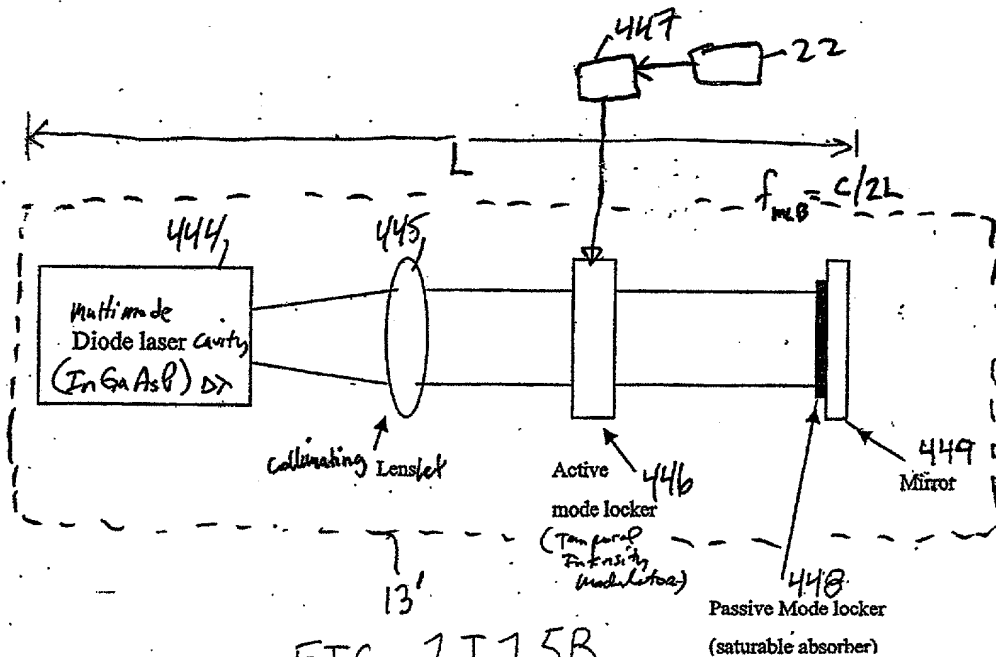
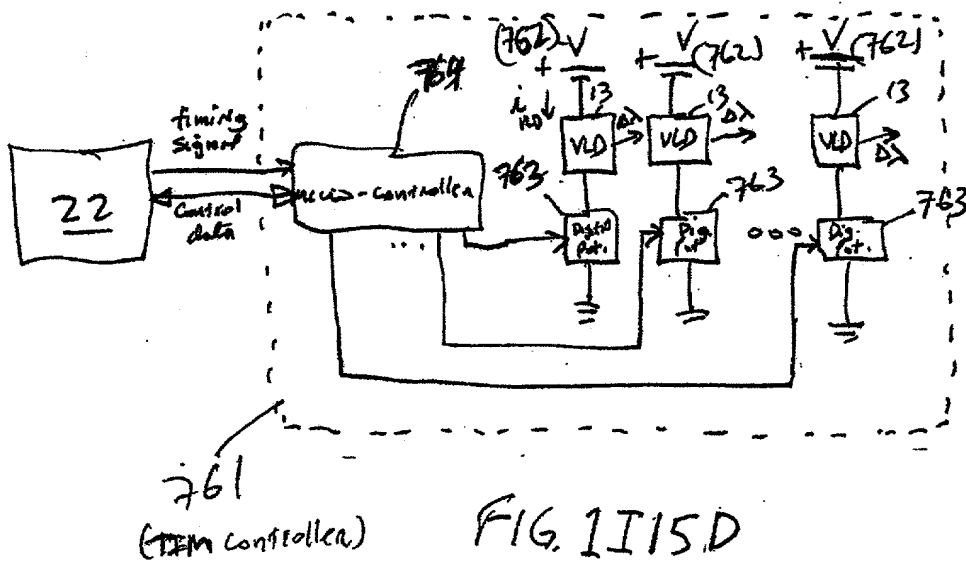
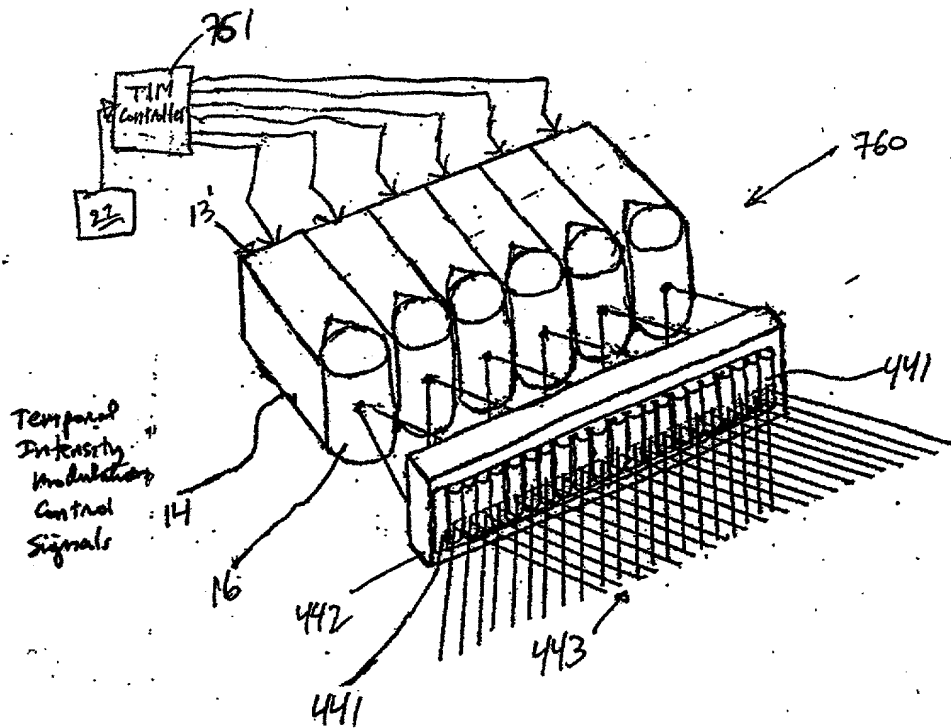


FIG. 1I15B

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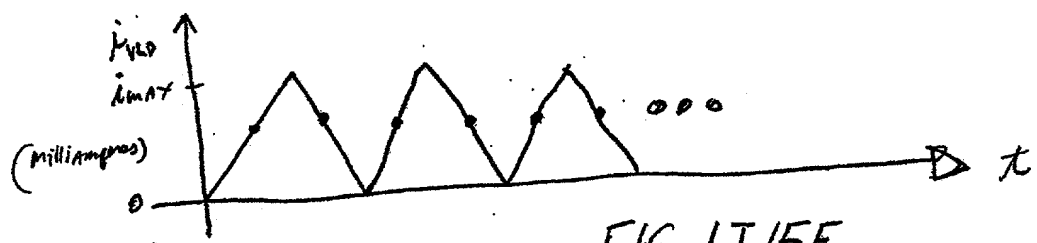


FIG. 1I15E

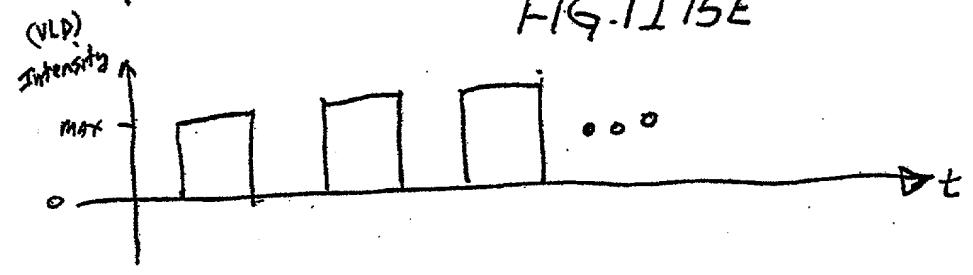


FIG. 1I15E

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Third Generalized Method of  
Reducing Speckle-Noise Patterns  
at Image Detection Array  
of FPD Subsystem (3)

(TIME)

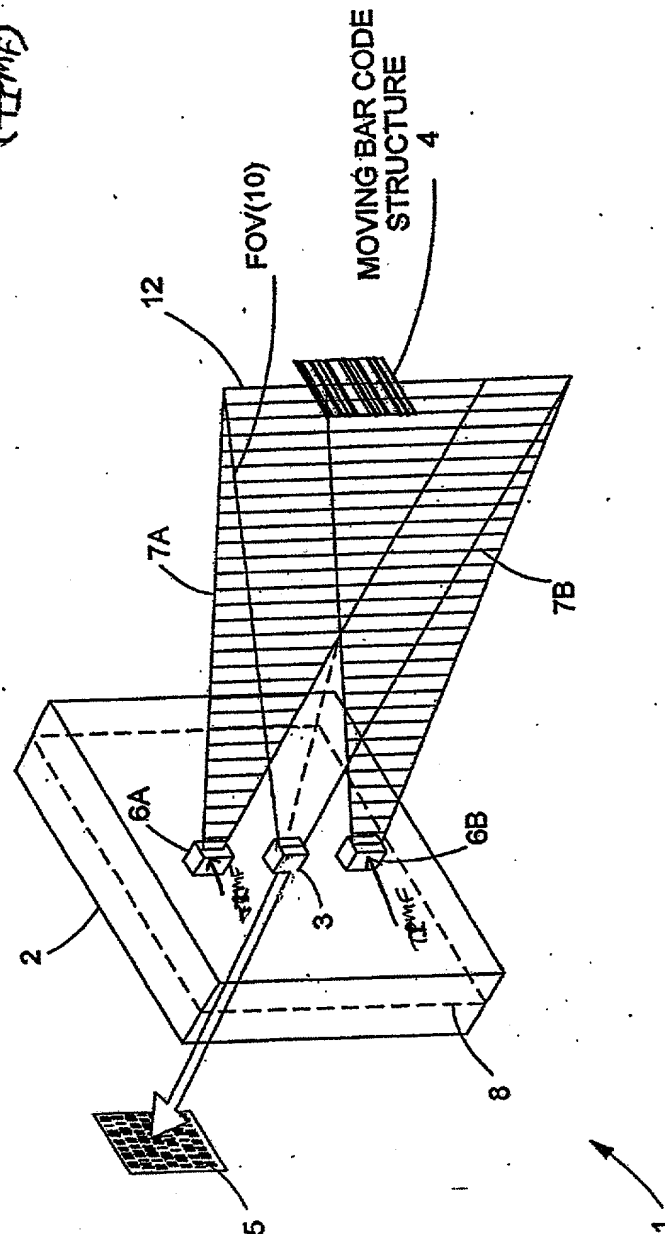


FIG. 1116

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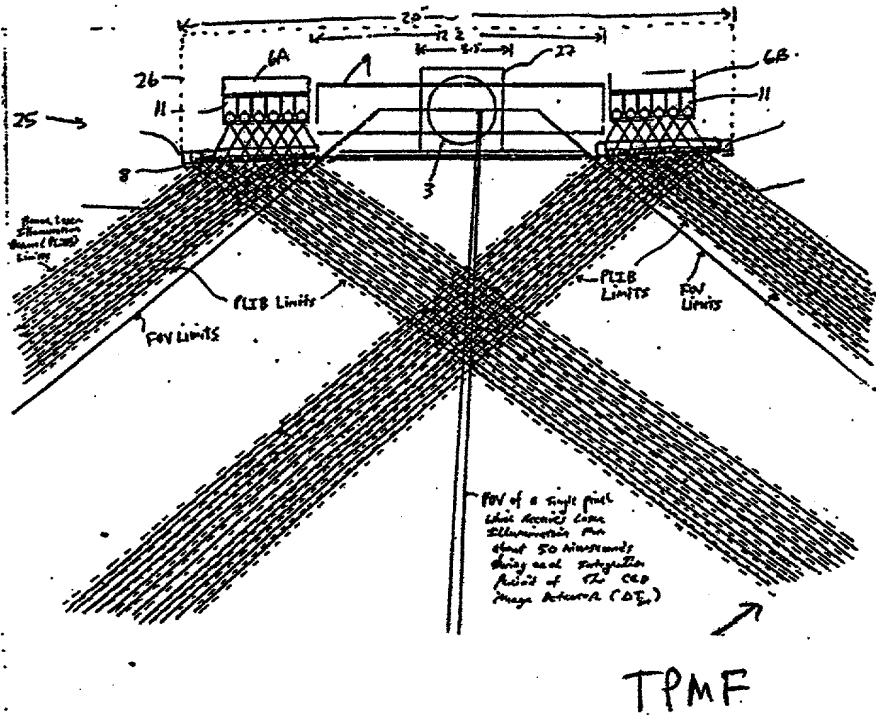


FIG. 1 I 16A

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Third Generalized Speckle-Noise Pattern Reduction Method  
Of The Present Invention

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal *phase* of the transmitted PLIB along the ~~planar extent thereof~~ according to a *temporal phase* modulation function (TPMF) so as to:

produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce power of the speckle-noise pattern observed at the image detection array.

FIG. 1I/6B

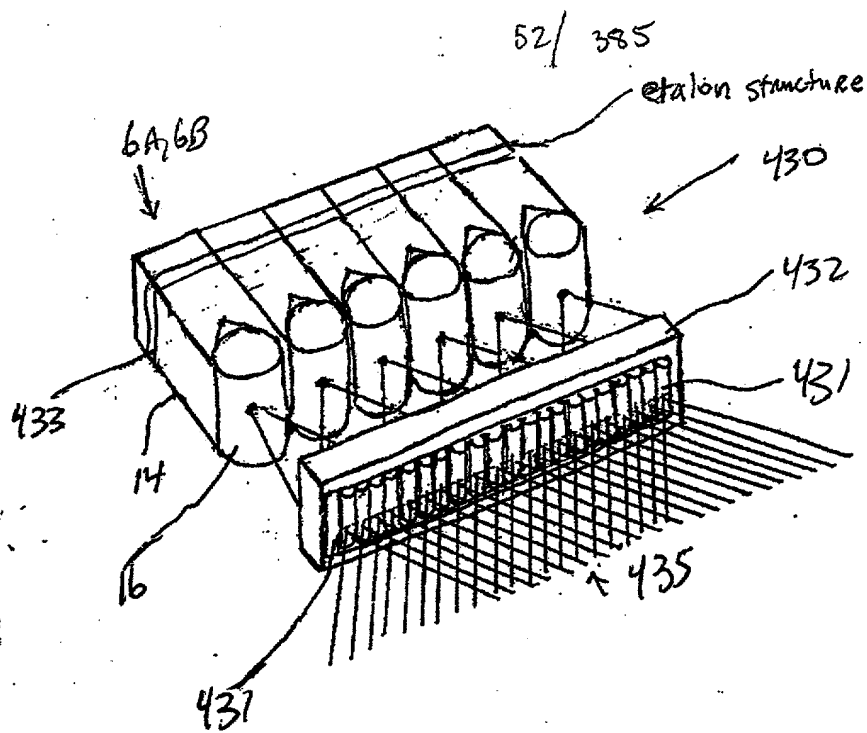


FIG. 1I17A

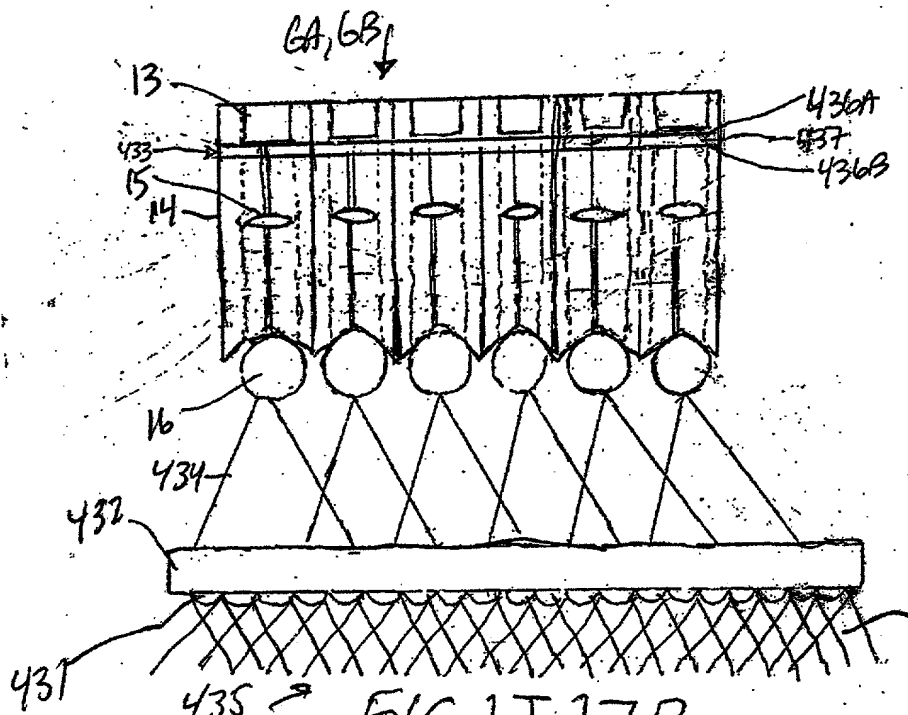
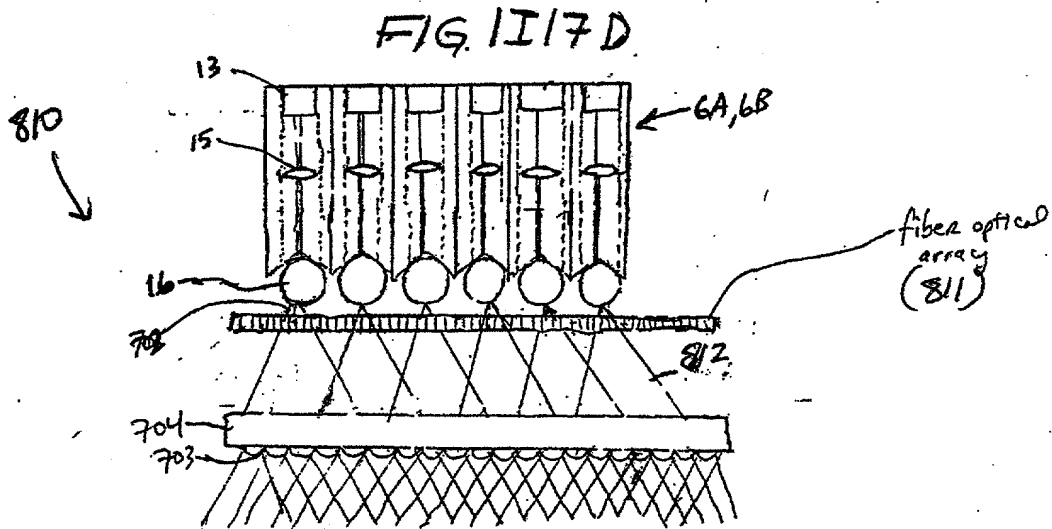
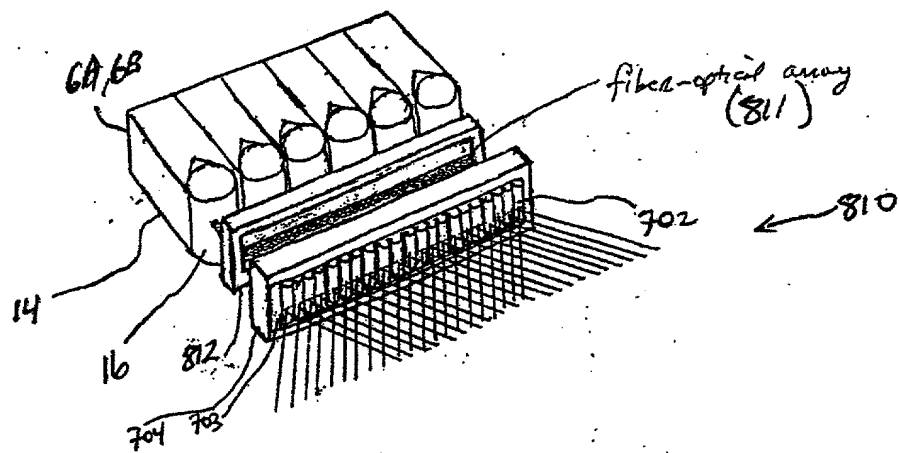
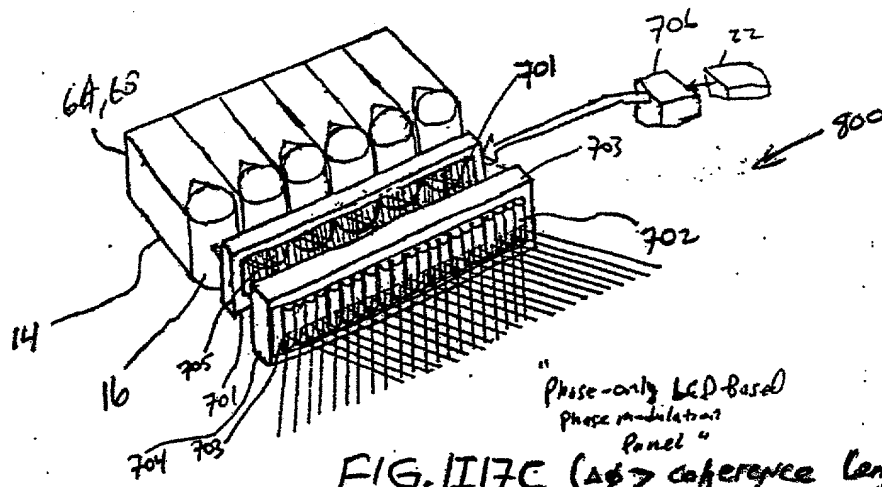


FIG. 1I17B



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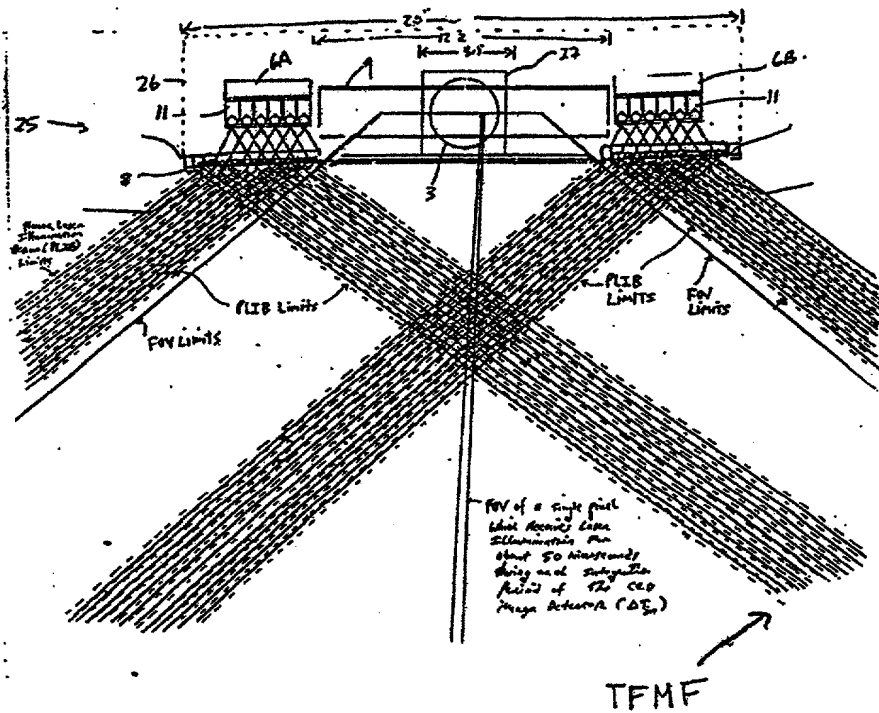


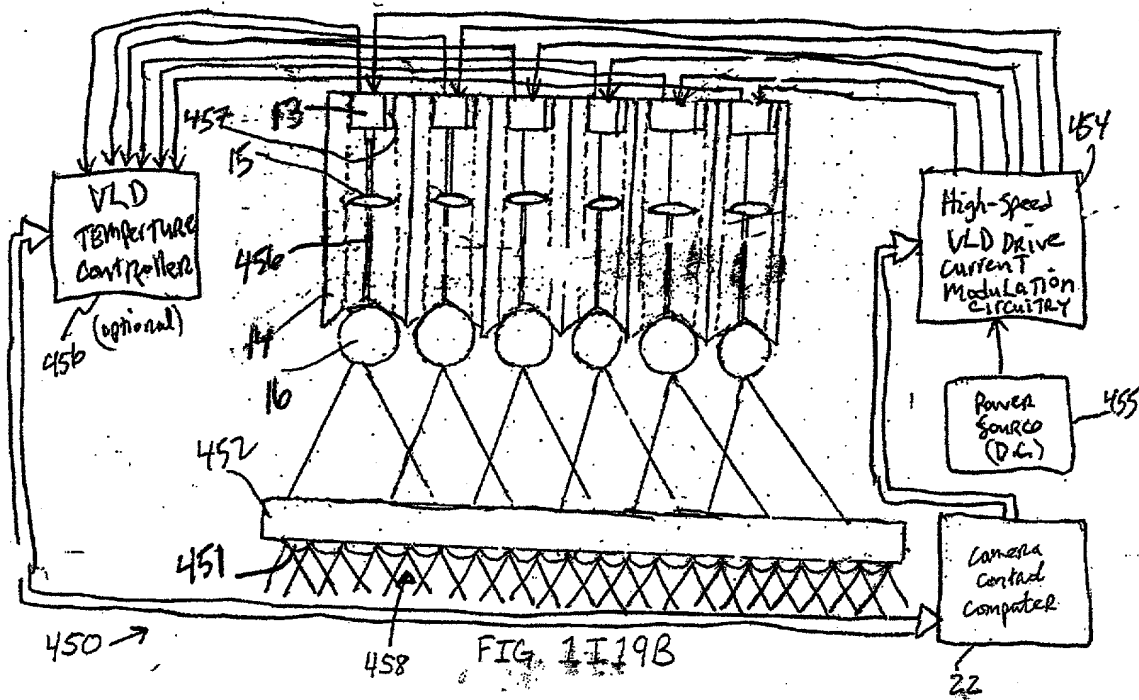
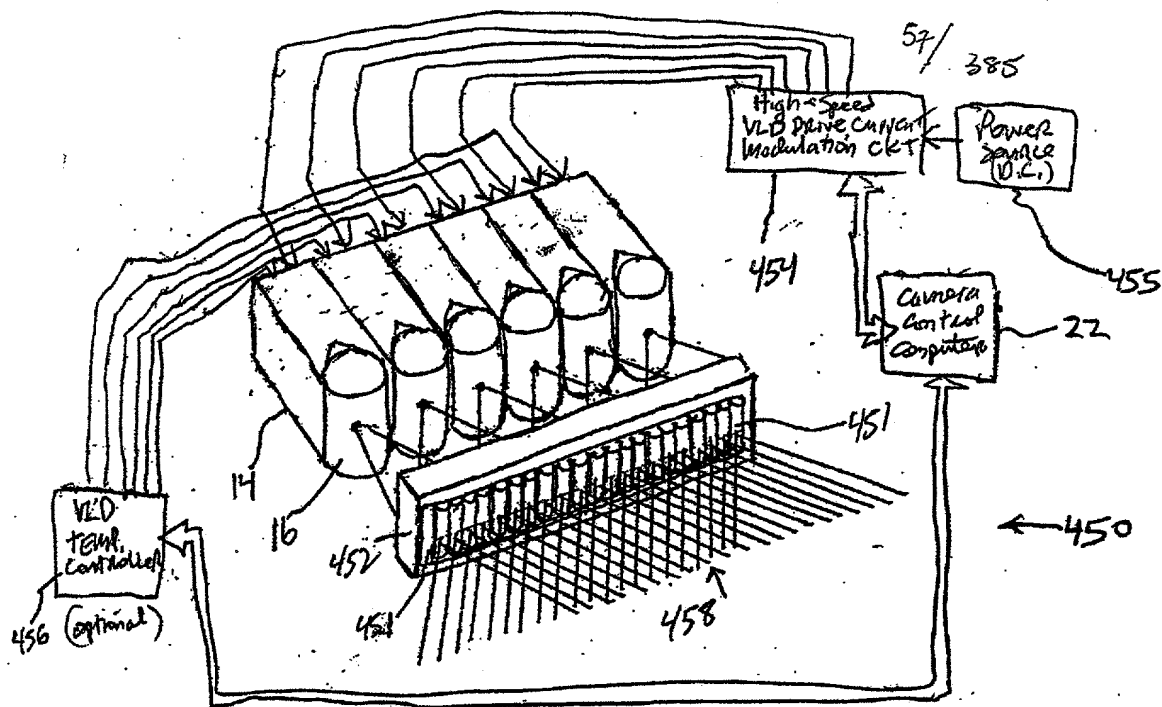
FIG. 1 I 18A

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal frequency of the transmitted PLIB according to a temporal intensity modulation function (T MF) so as to:

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce power of the speckle-noise pattern observed at the image detection array.

FIG 1I/BB

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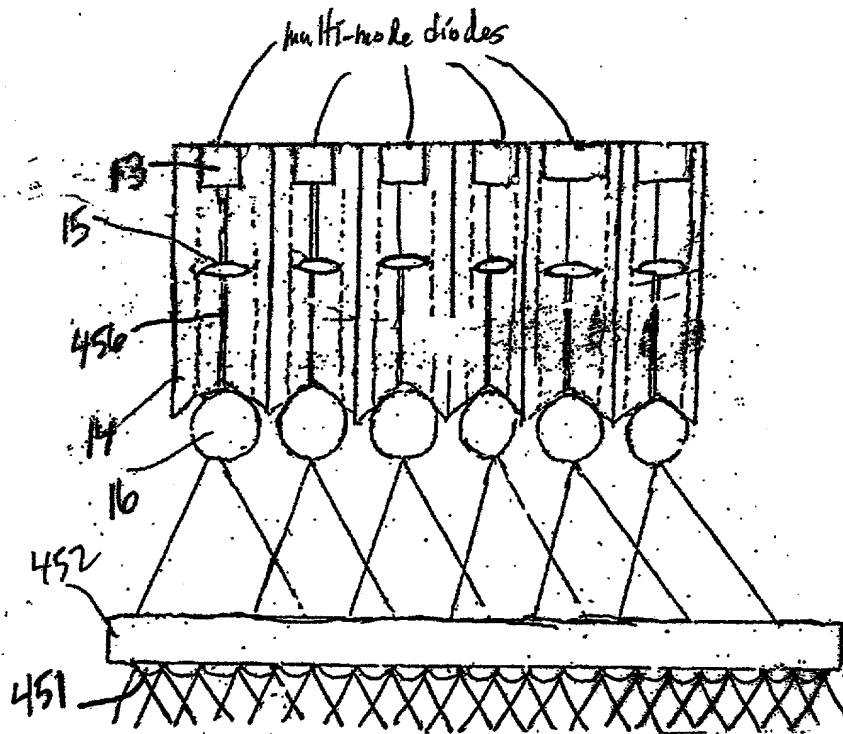


FIG 1I19C

10068462.020702

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Fifth Generalized Method  
of Reducing Speckle-Noise  
Patterns AT Image  
Detection array of the  
FPD subsystem (3)

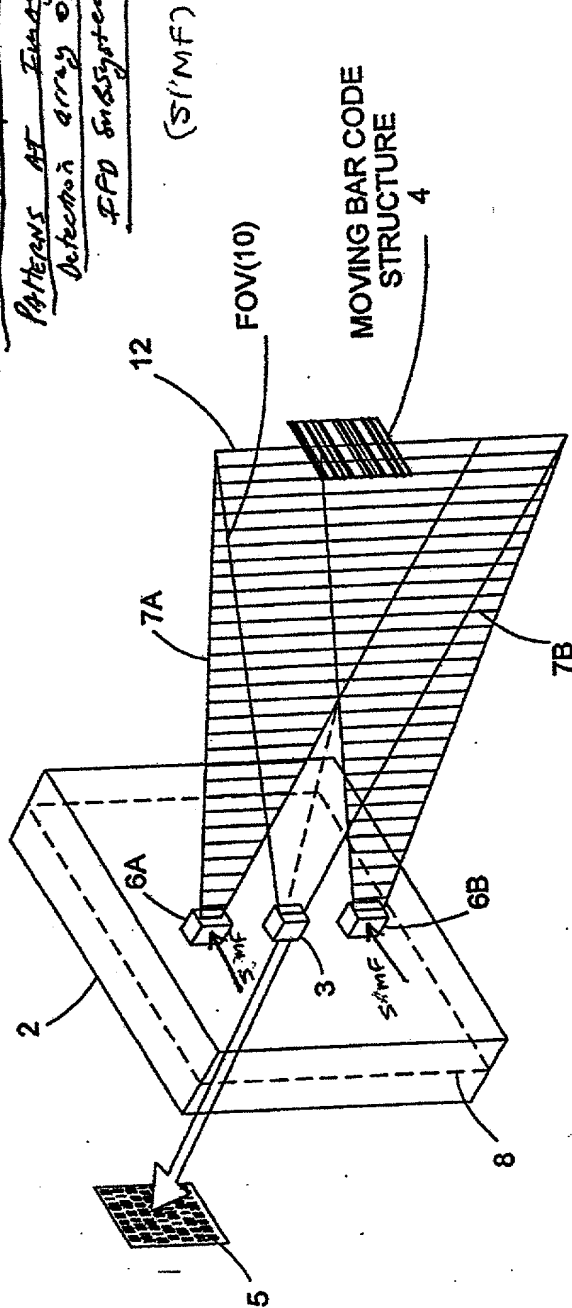


FIG 1E 20

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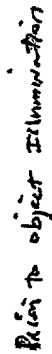


FIG. 1 I ZOA



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Fifth Generalized Speckle-Noise Pattern Reduction Method  
Of The Present Invention

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial intensity of the transmitted PLIB along the planar extent thereof according to a spatial intensity modulation function (SIMF) so as to :

produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

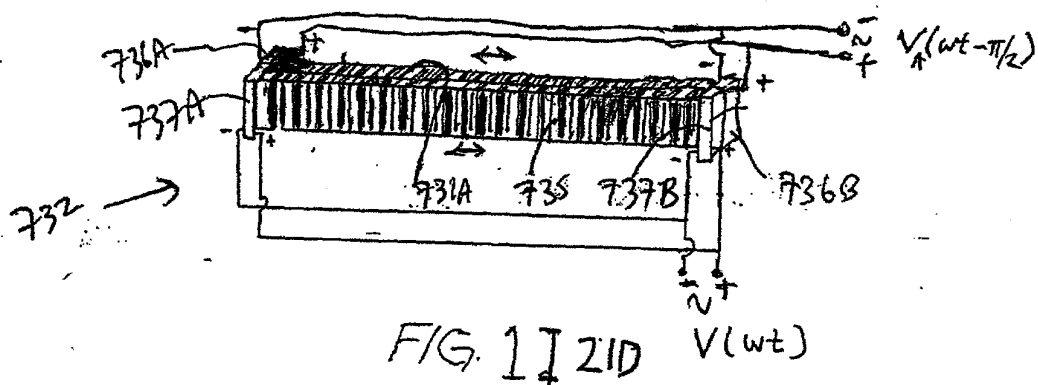
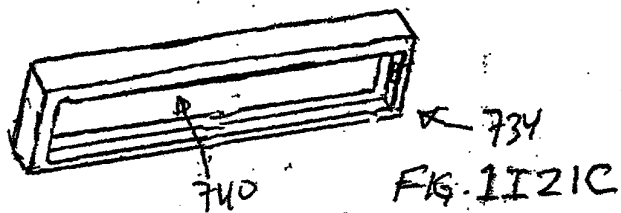
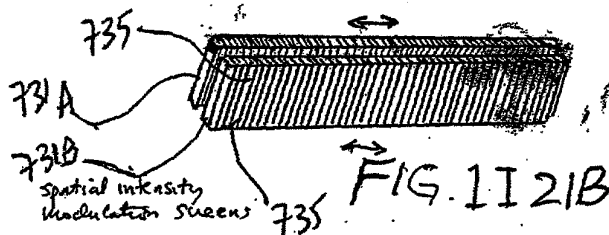
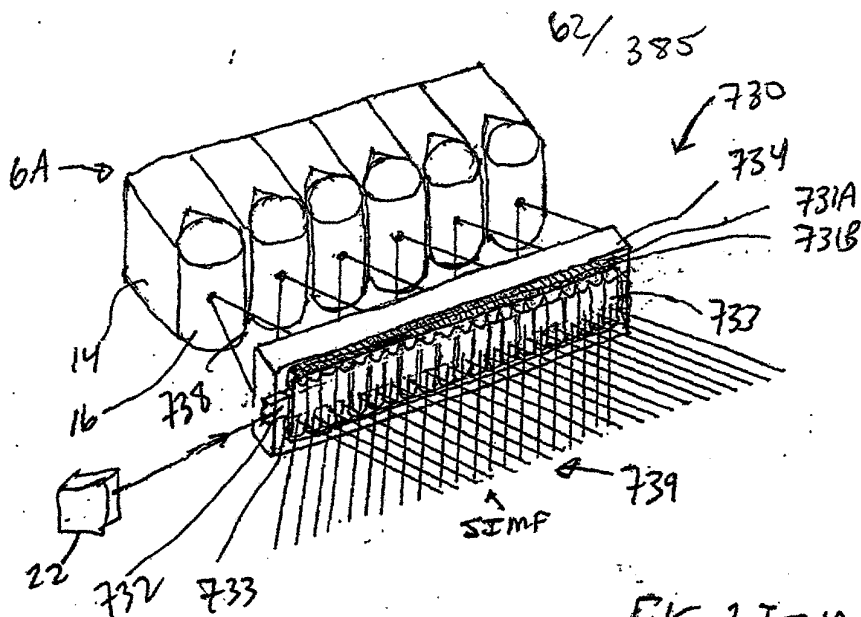
A

↓  
Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce power of the speckle-noise pattern observed at the image detection array.

B

FIG. 1I20B

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Generalized Method of  
Reducing Speckle-Noise Patterns  
at Image Detection array  
of the ICD Subsystem

(SIMF)

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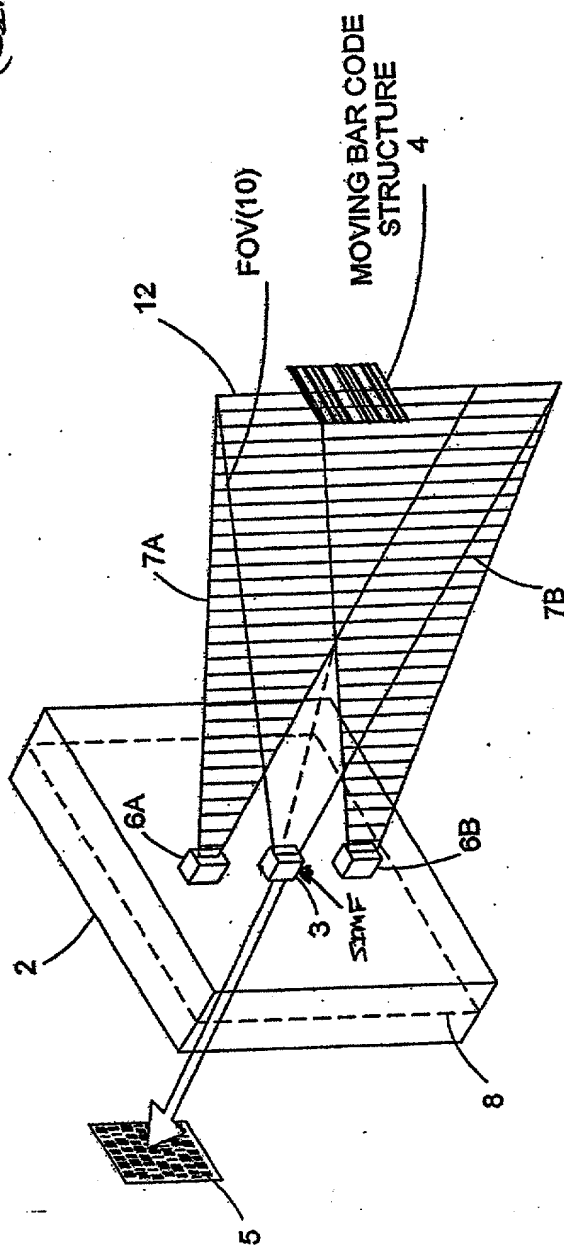


FIG. 1I 22

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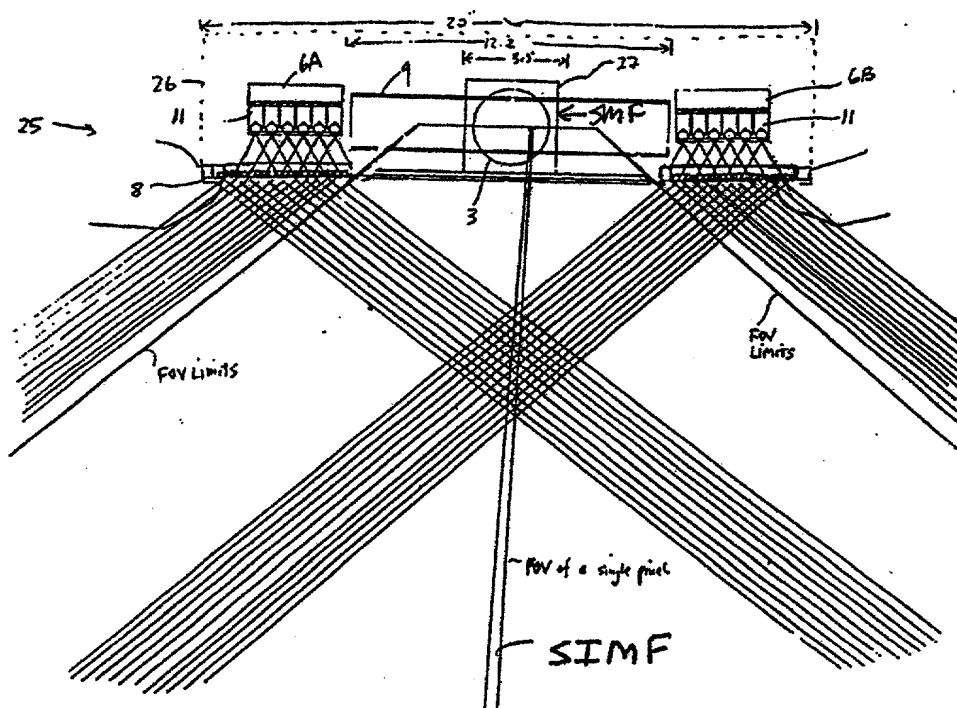


FIG. 1I22A

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Sixth Generalized Speckle-Noise Pattern Reduction Method  
Of The Present Invention

After illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial intensity of the reflected/scattered (i.e. received) PLIB along the planar extent thereof according to a spatial intensity modulation function (SIMF) so as to:

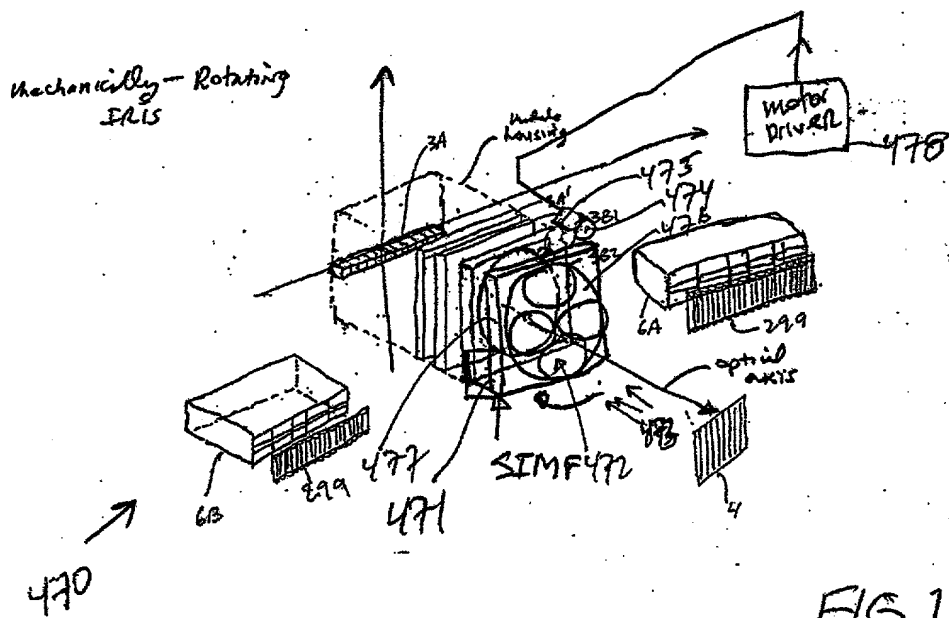
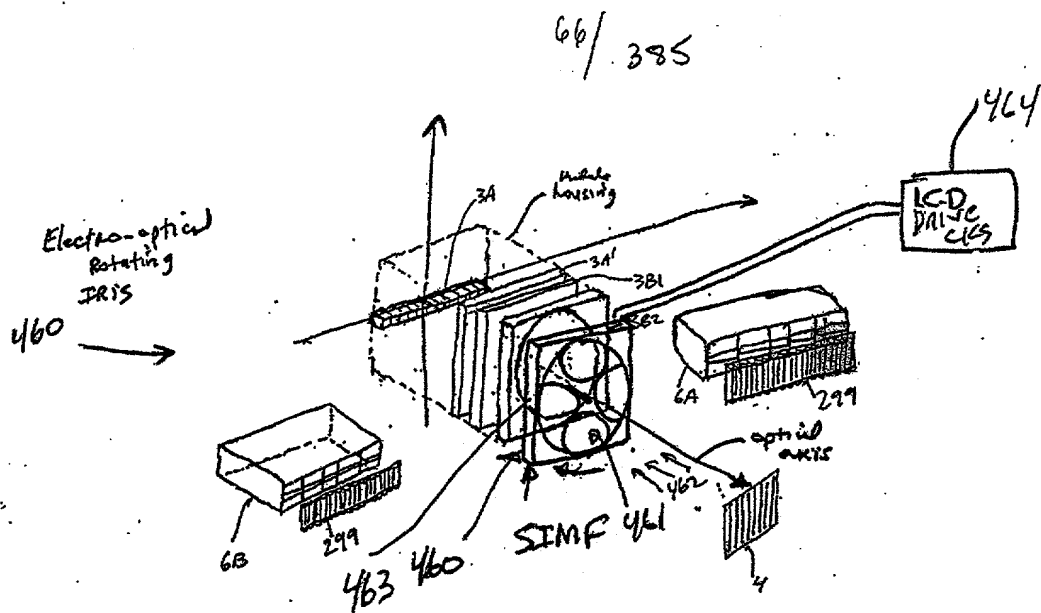
produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

Temporally average the many substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the speckle-noise pattern observed at the image detection array.

FIG. 1I 22B

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Seventh Generalized Method of  
Reducing Specular-Noise Patterns  
at Image Detection Array  
of the IPD Subsystem

(TIME)

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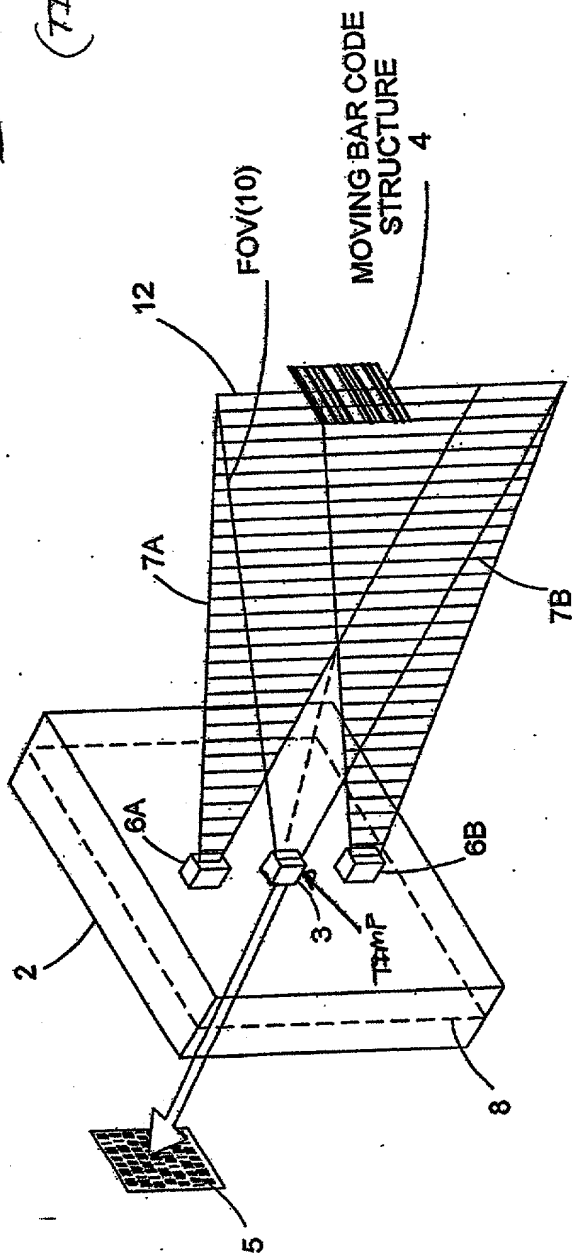


FIG. 1124

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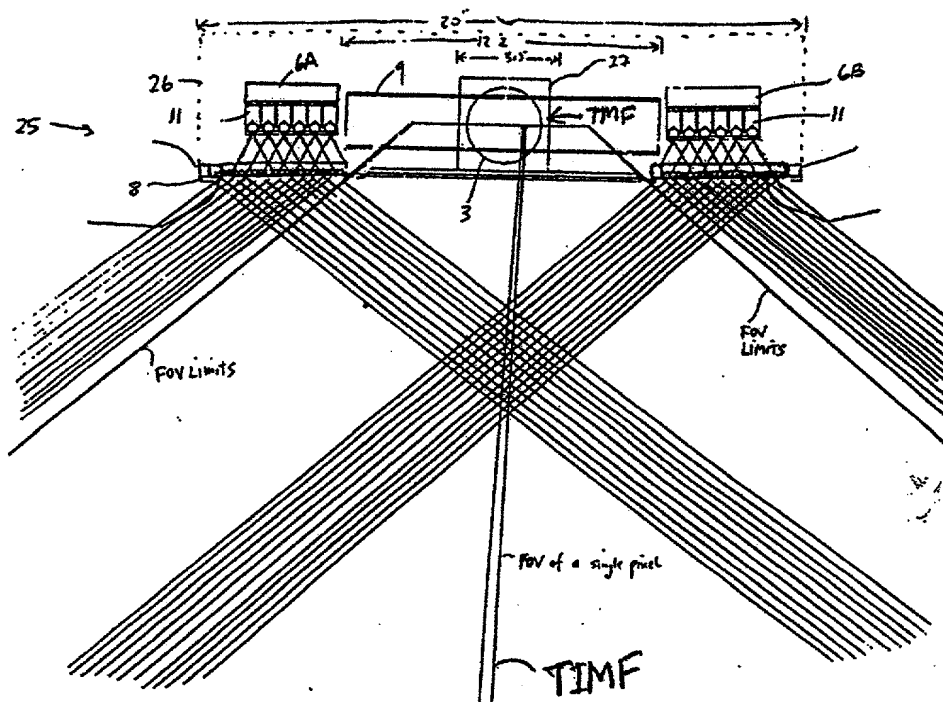


FIG. 1I24A

10068462.020702



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Seventh Generalized Speckle-Noise Pattern Reduction Method  
Of The Present Invention

After illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal intensity of the reflected/scattered (i.e. received) PLIB along the planar extent thereof according to a temporal intensity modulation function (TIMF) so as to :

produce many substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

Temporally average the many substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the speckle-noise pattern observed at the image detection array.

FIG. 1I 24B

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EIGHT GENERALIZED METHOD OF REDUCING THE SPECKLE PATTERN  
NOISE OBSERVED IN PLIIM-BASED IMAGING SYSTEMS

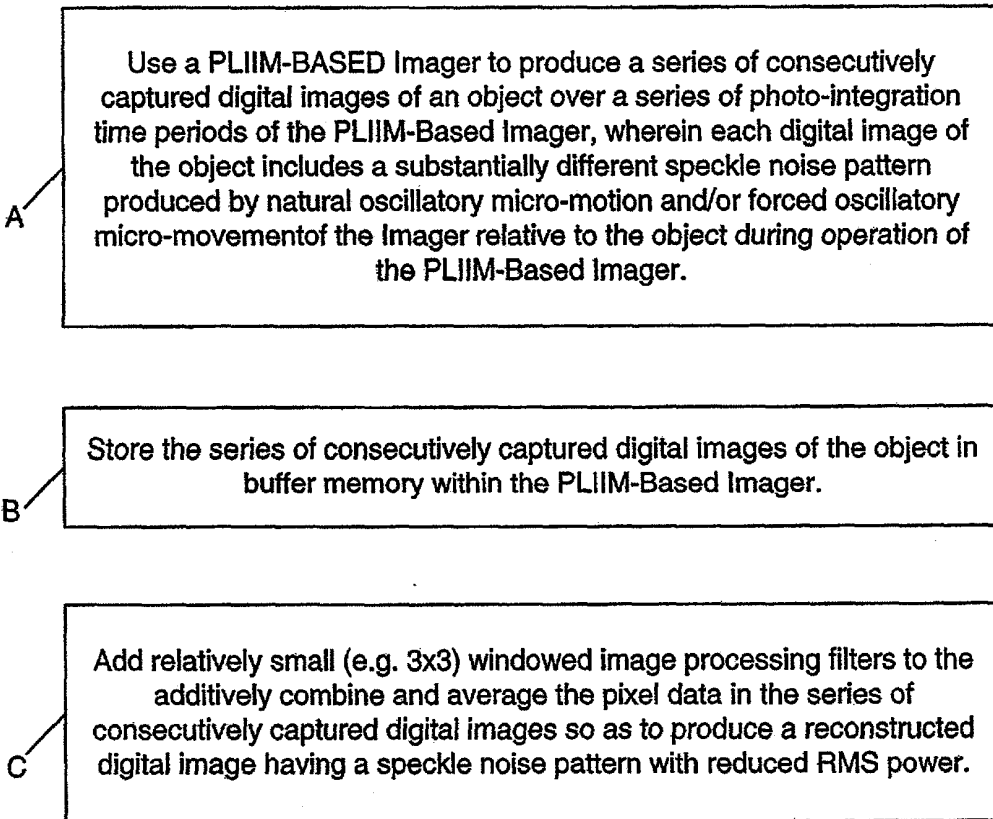
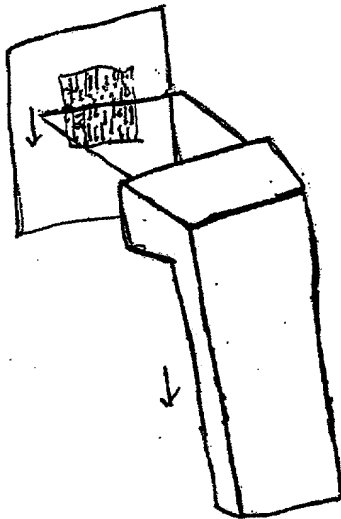


FIG. 1124D

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Manual  
Sweeping  
Action  
across Code Symbol  
or  
graphical indicia

FIG. 1I24E

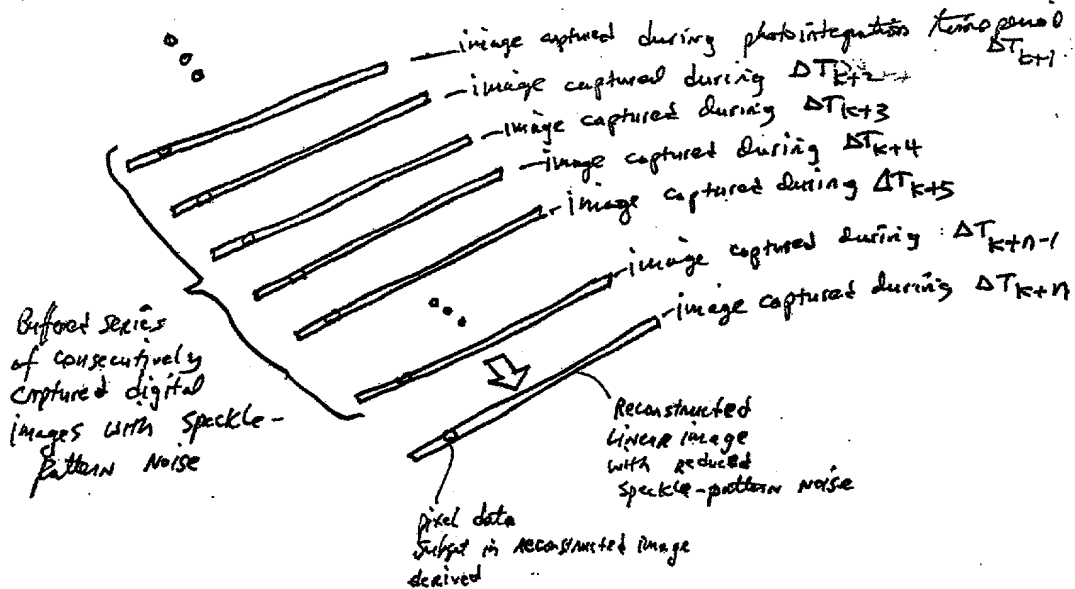


FIG. 1I24F

Case: Linear Image

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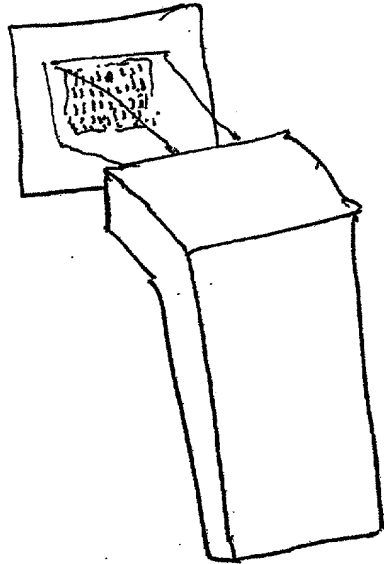


FIG. 1I24G

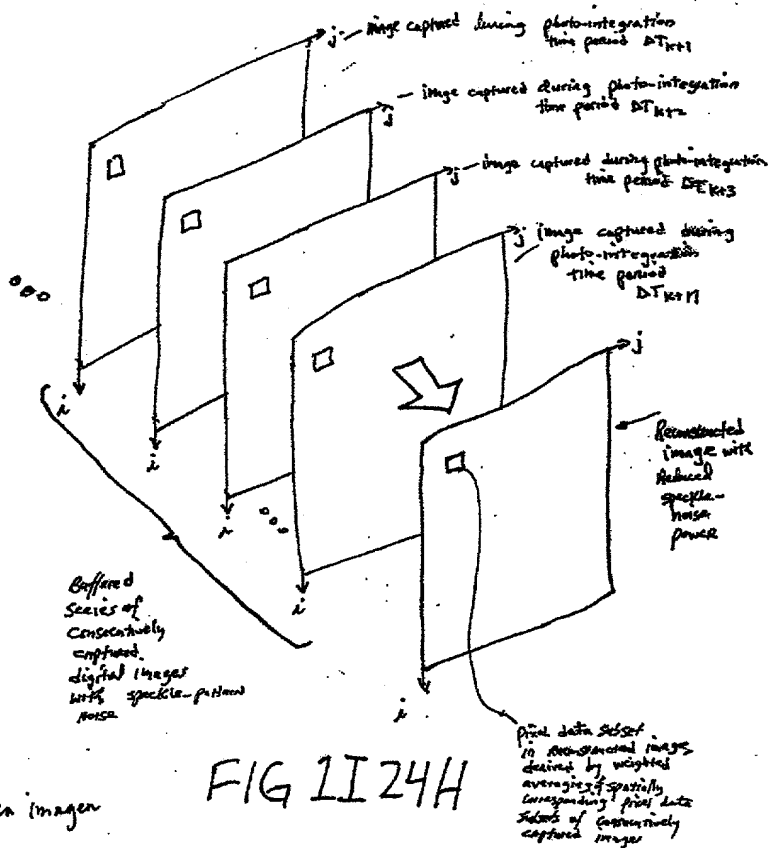


FIG 1I24H

Case: 2D Area Imager

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NINTH GENERALIZED METHOD OF REDUCING SPECKLE PATTERN  
NOISE IN PLIIM-BASED IMAGING SYSTEMS

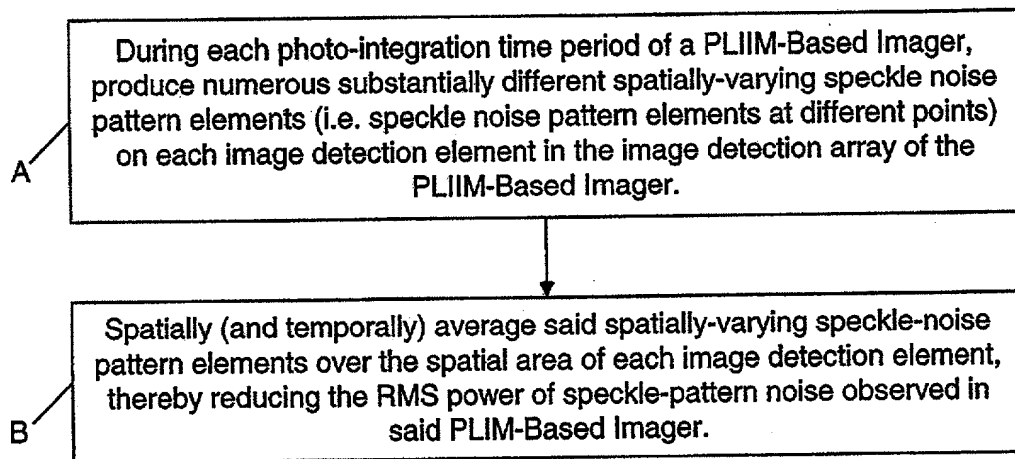
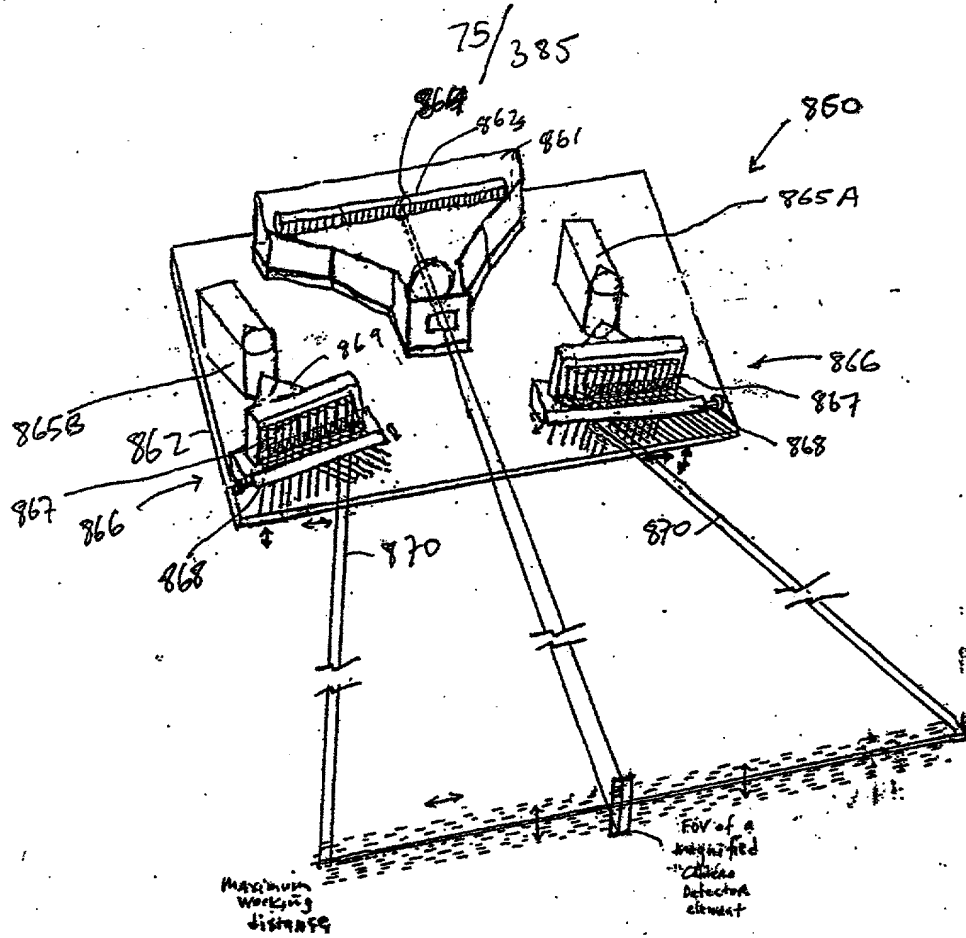


FIG. 1124I

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\* Lateral and Transverse Microoscillation of PLIB

FIG. 1I25A1

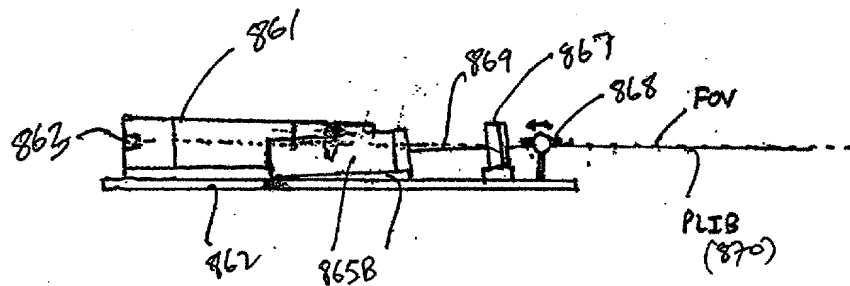
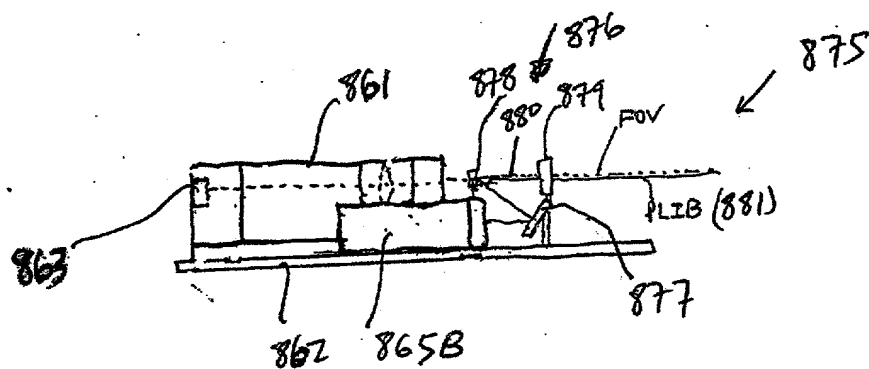
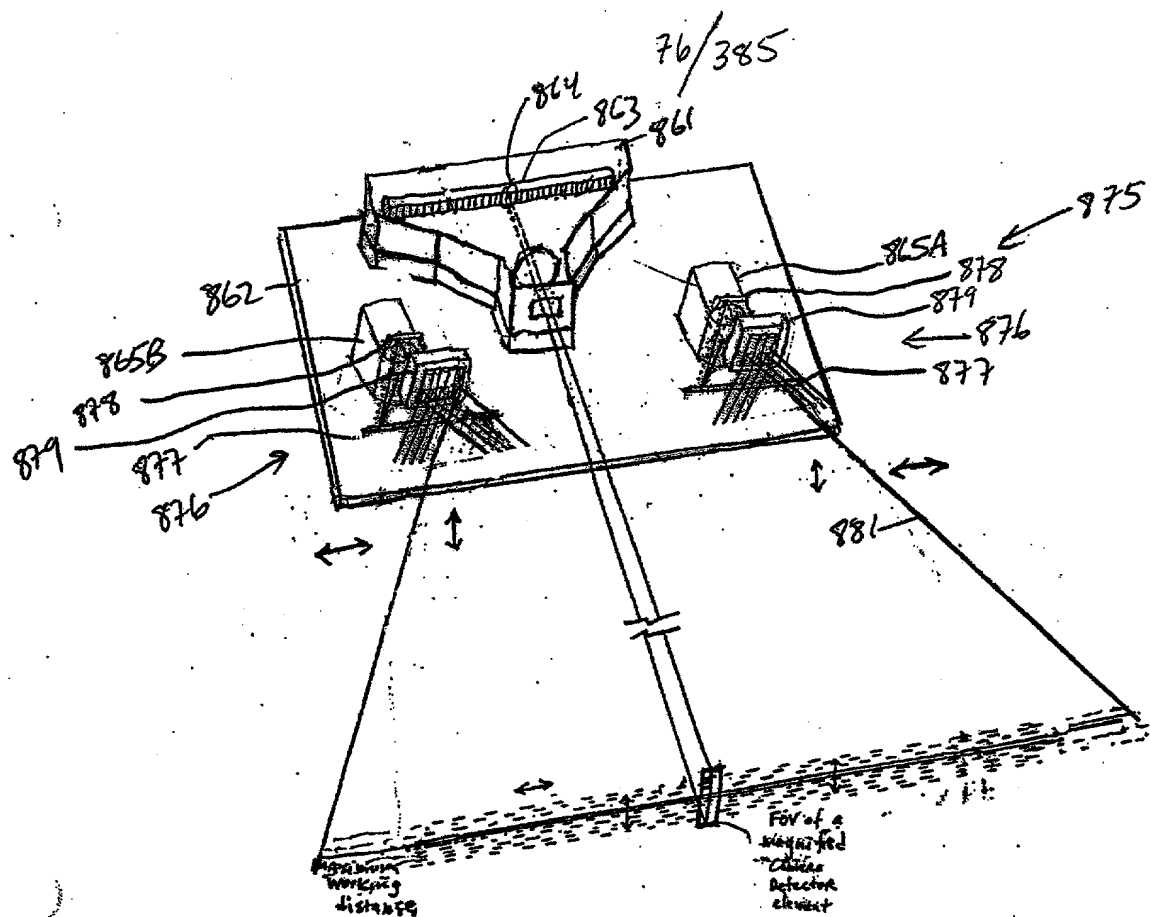


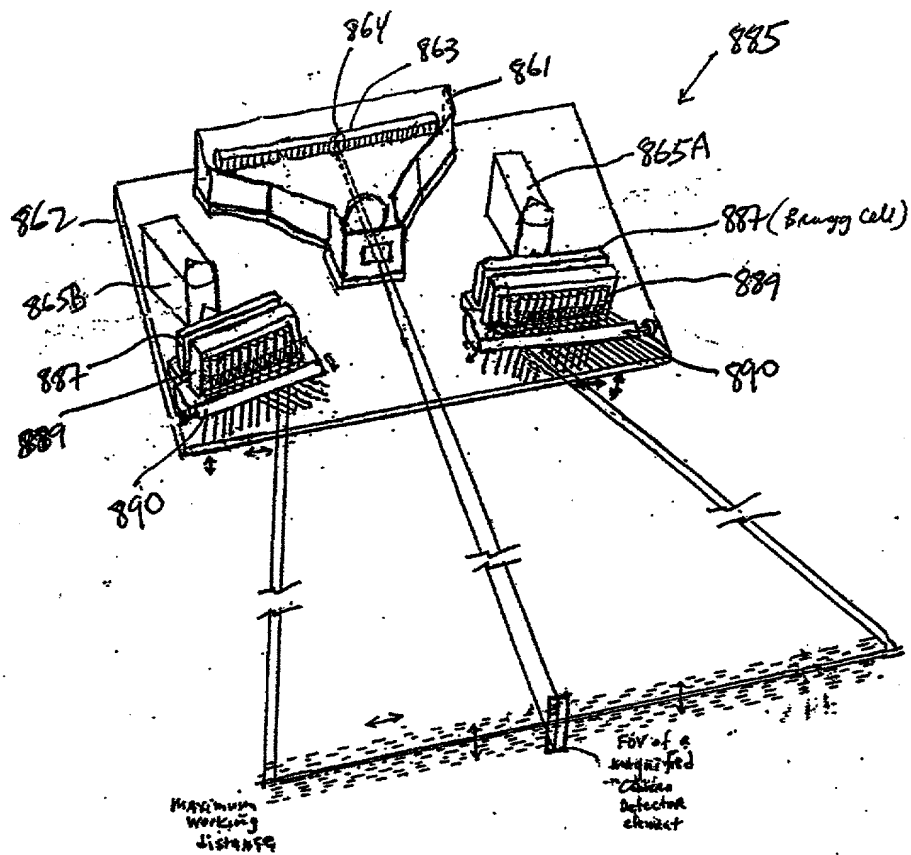
FIG. 1I25A2





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\* Lateral and Transverse Misalignment of PLIB

FIG. 1I25C1

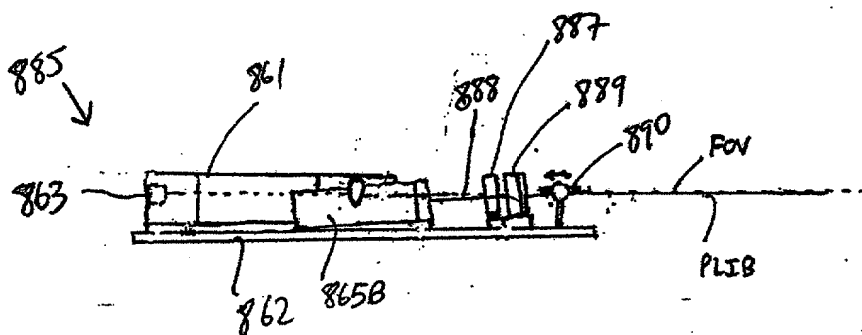
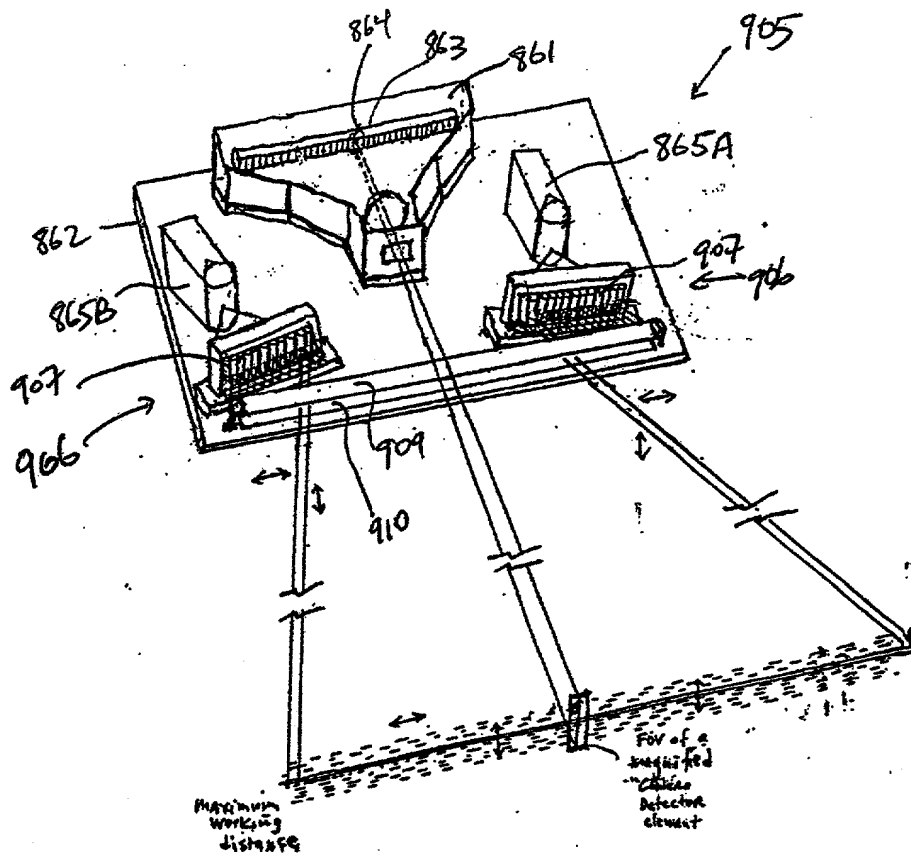


FIG. 1I25C2



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\* Lateral and Transverse Microoscillation of PLIB

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FIG. 1I25E1

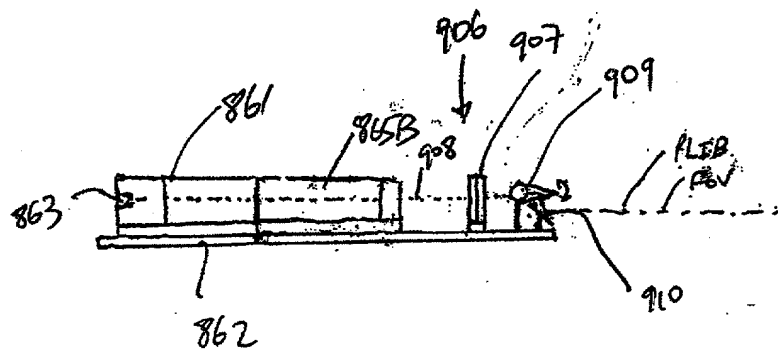
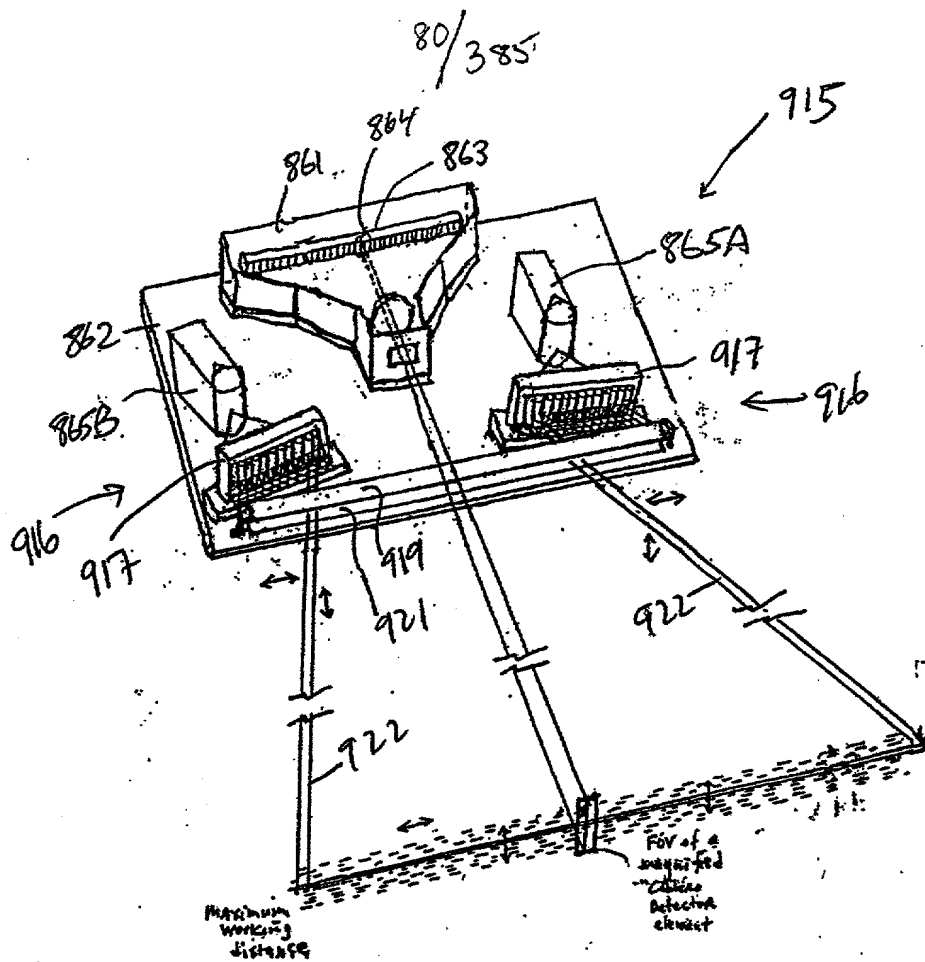


FIG. 1I25E2



\* Lateral and Transverse Microoscillation of ALIB

FIG. 1I25F1

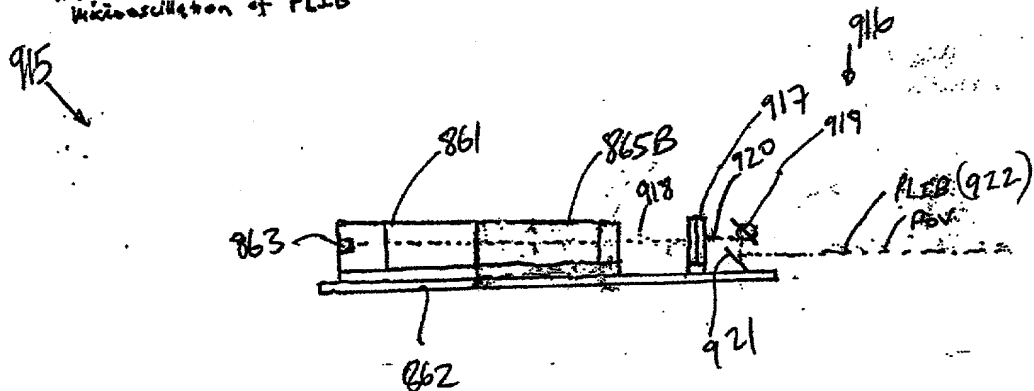


FIG. 1I25F2

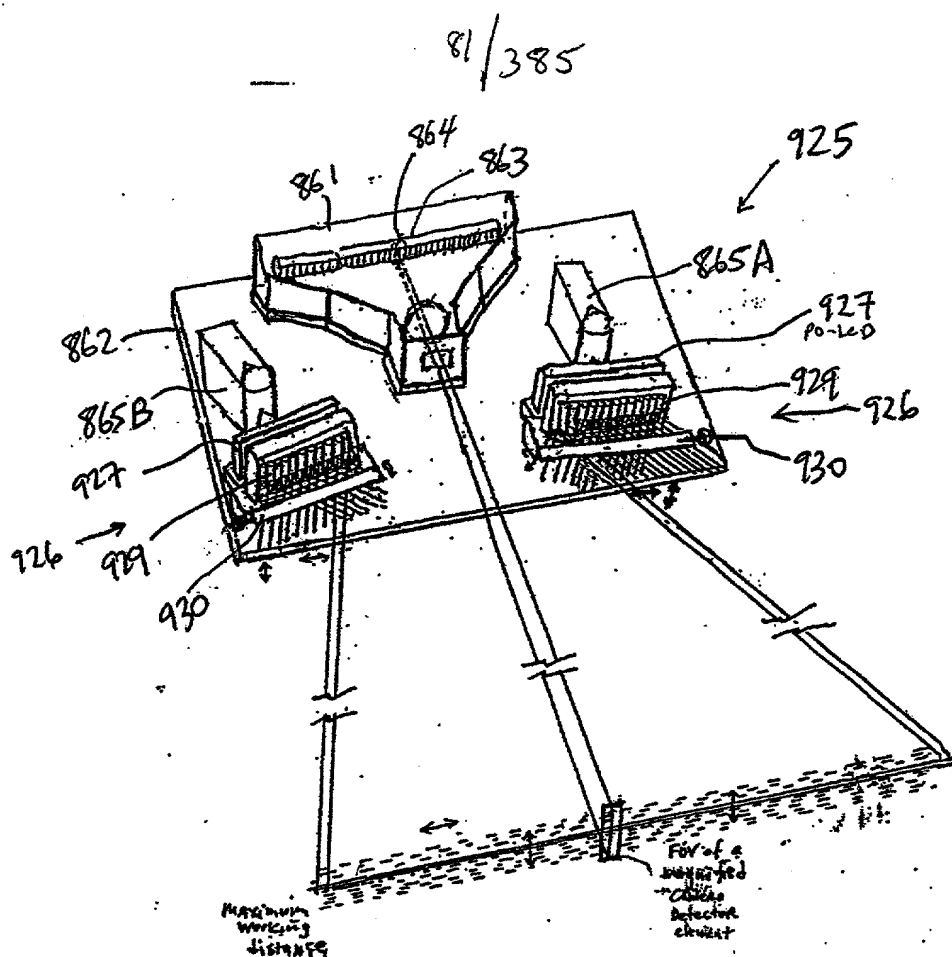


FIG. 1I25G1

\* Lateral and Transverse Misalignment of PLIB

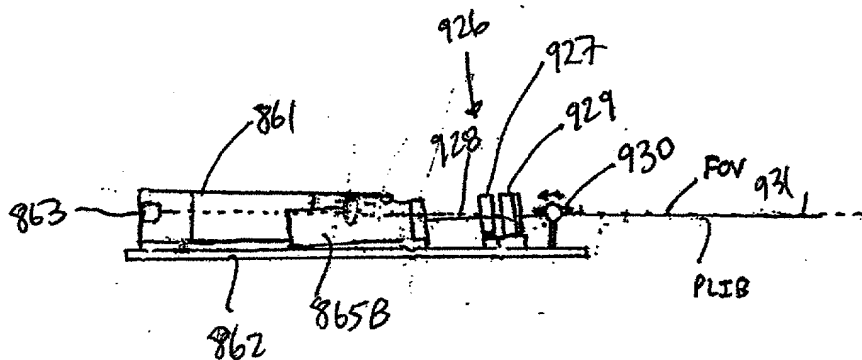
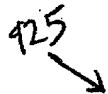
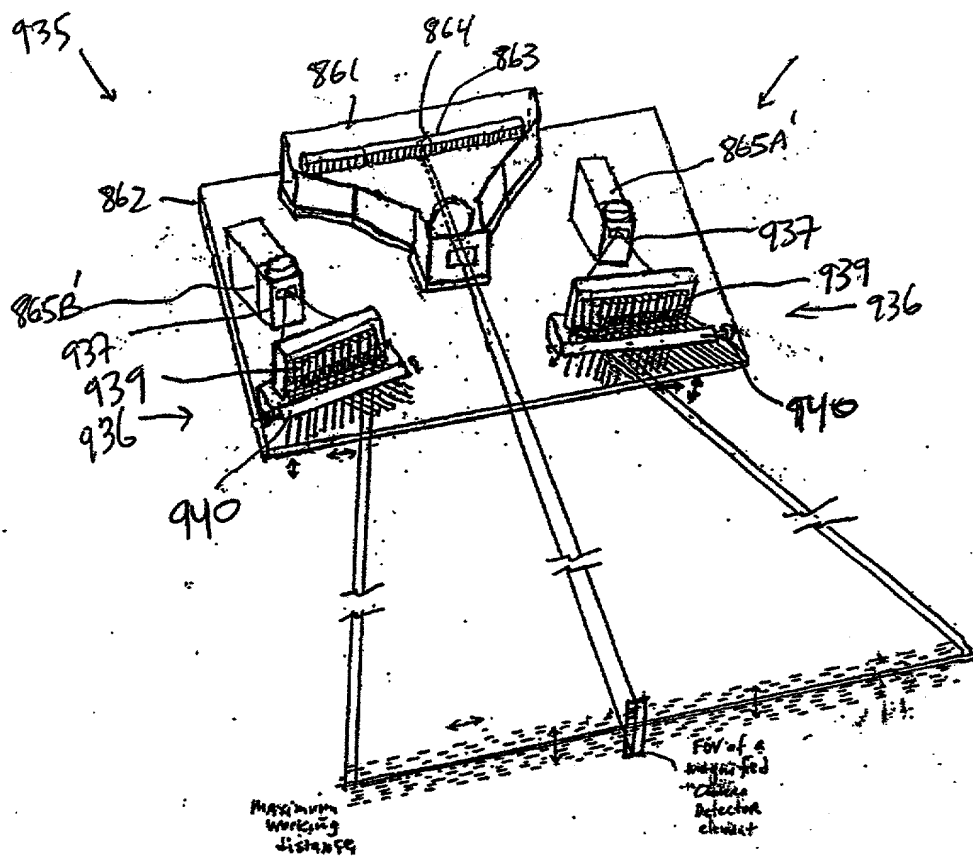


FIG. 1I25G2

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\* Lateral and Transverse Microoscillation of PLIB

FIG. 1I25H1

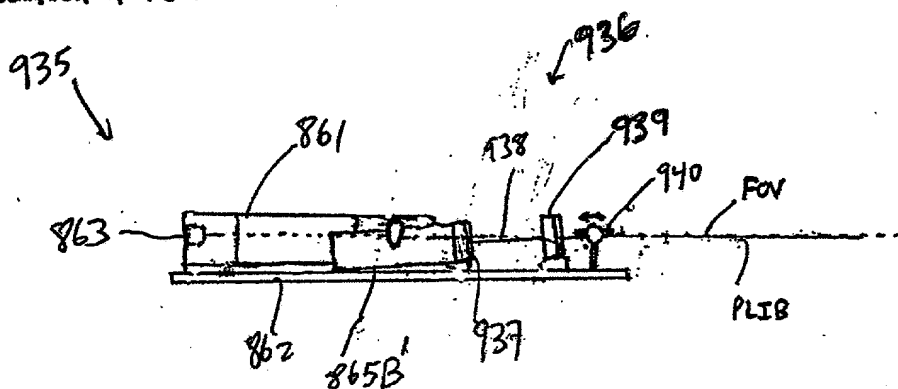


FIG. 1I25H2

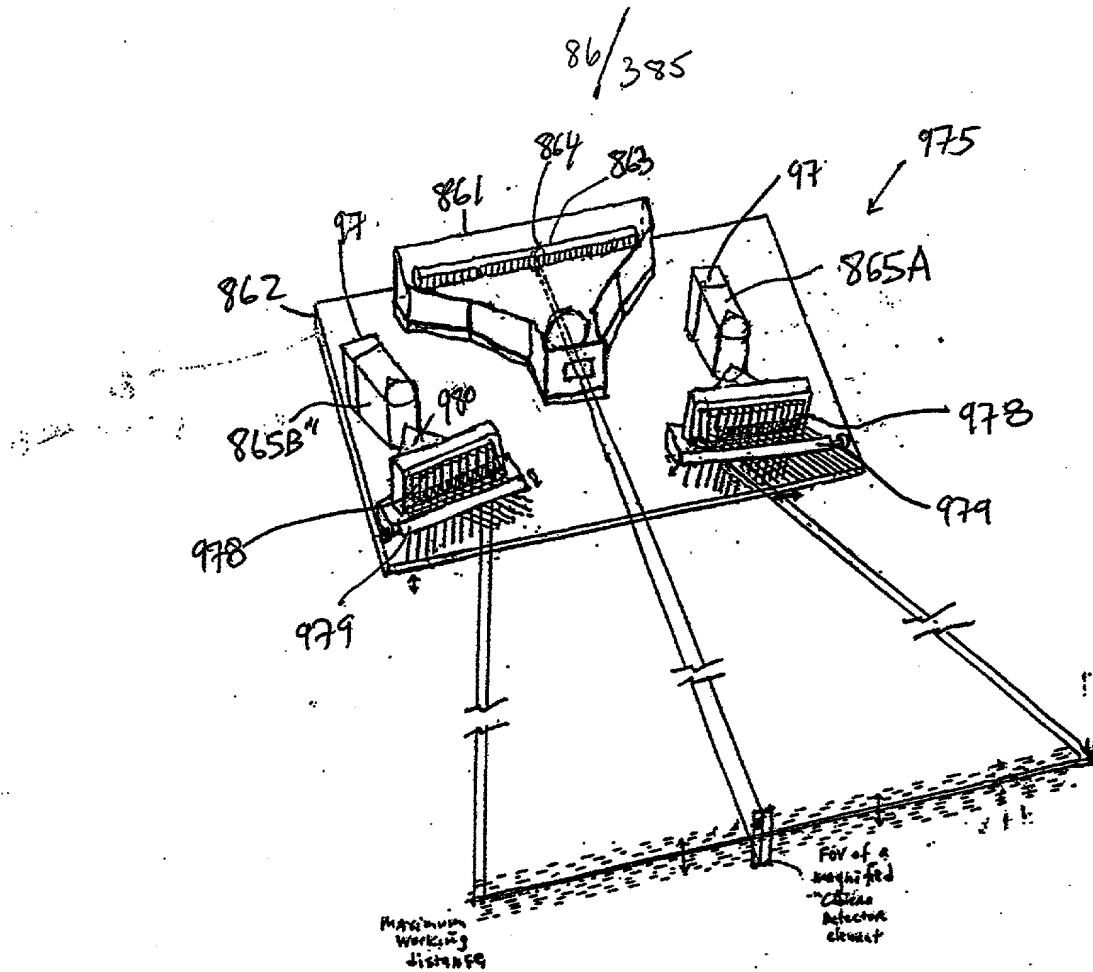
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FIG. 1 I 25 J 2







- \* hybrid =
- Temp. freq. mod.
- Spatial phase mod.

\* Transverse  
Modulation of PLIB

FIG. 1I25L1

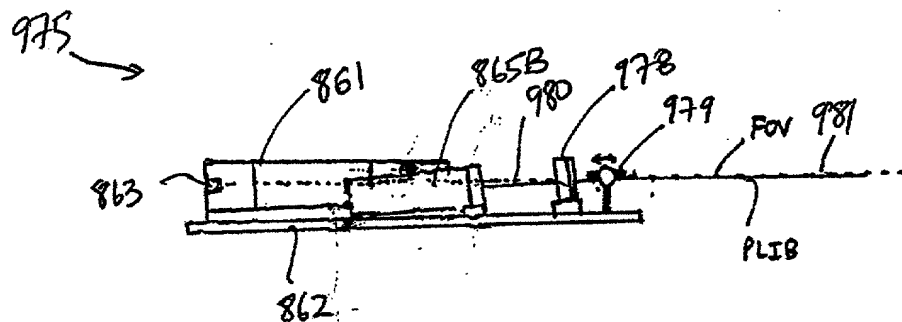


FIG. 1I25L2

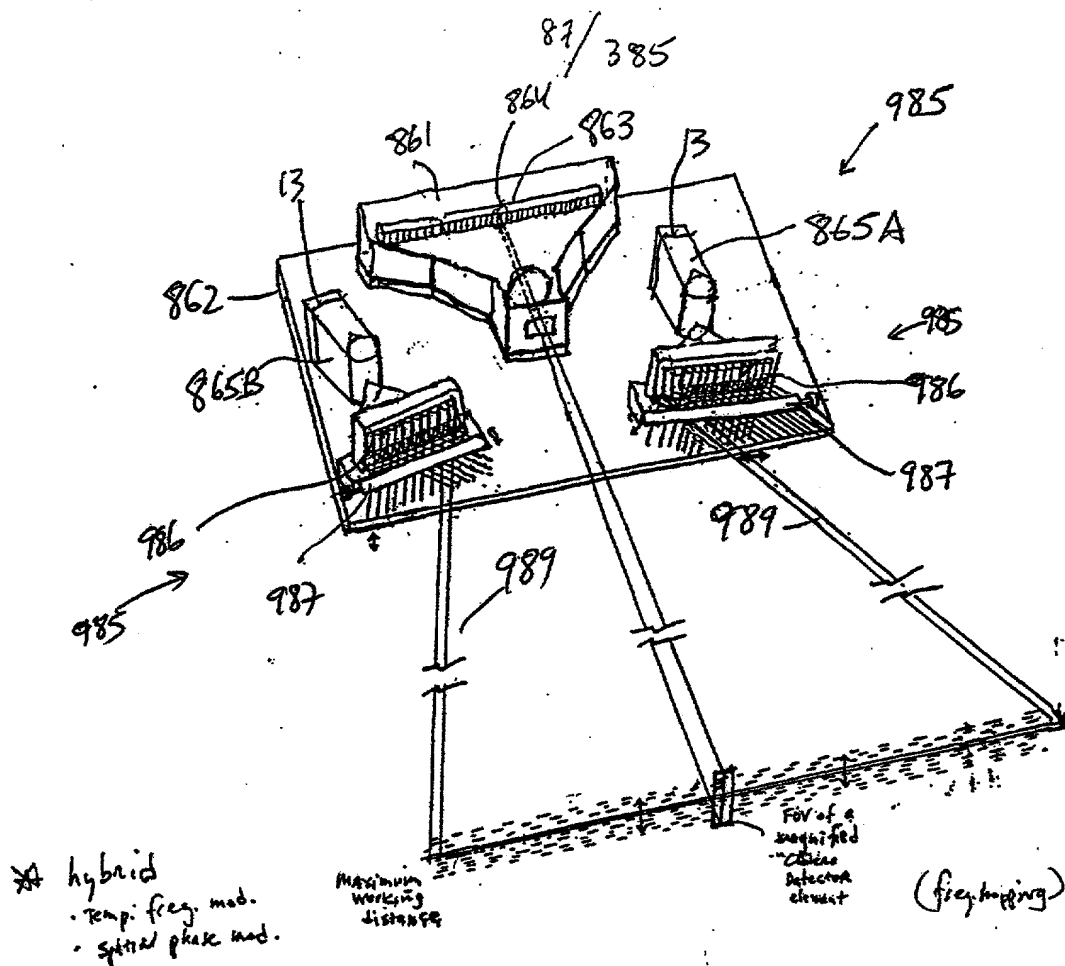


FIG. 1I25M1

\* Transverse magnification of PLIB

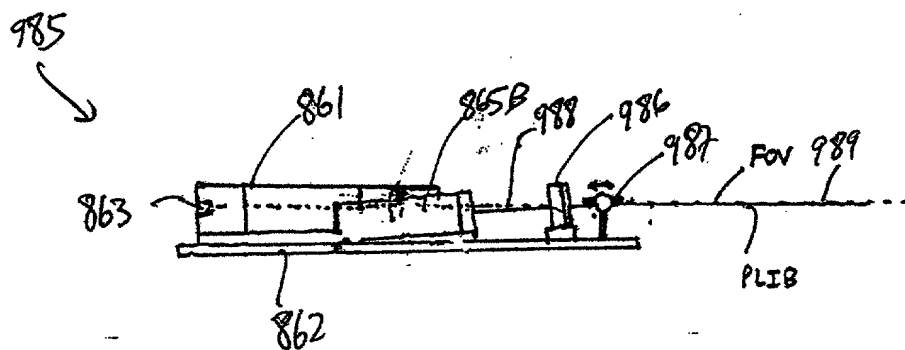


FIG. 1I25M2

- hybrid:
  - spatial intensity mod.
  - spatial phase

- \* Lateral and Transverse Excitation of PLIB

FIG. 1125N1

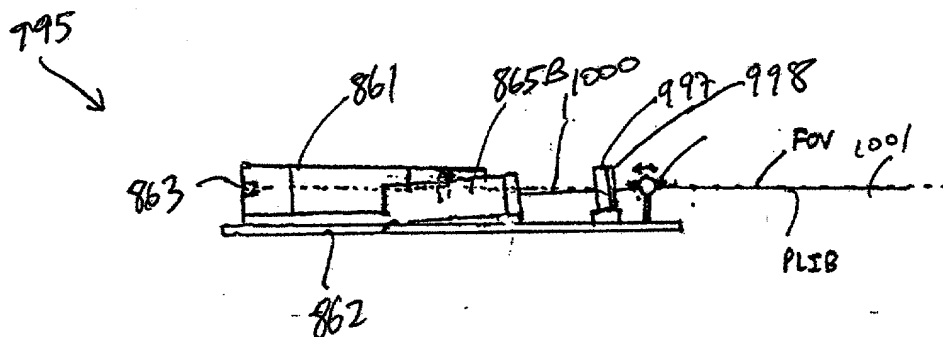


FIG. 1I25NZ

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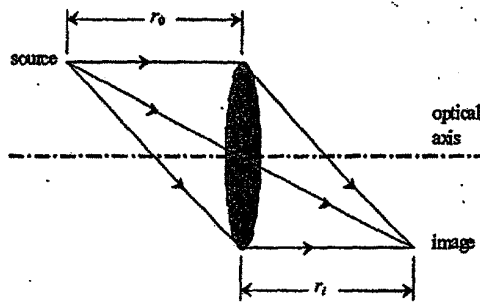


FIG. 1H1

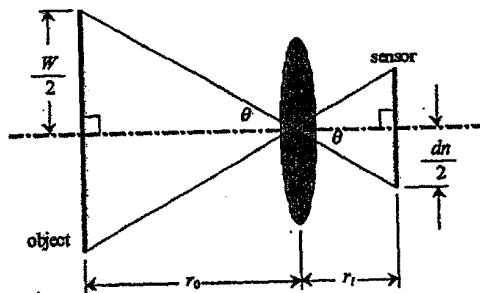


FIG. 1H2

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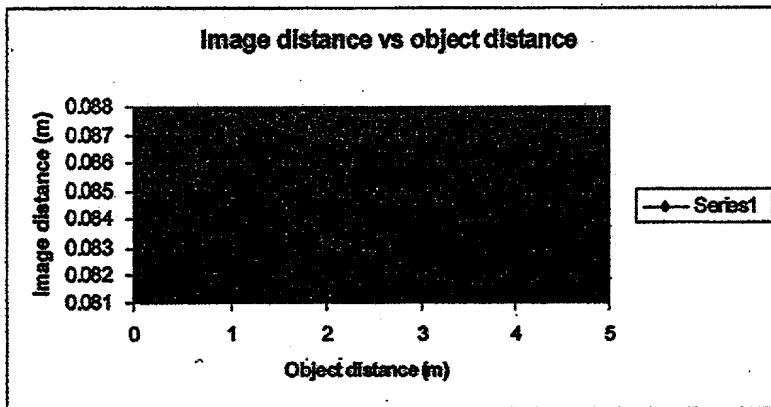


FIG. 1H3

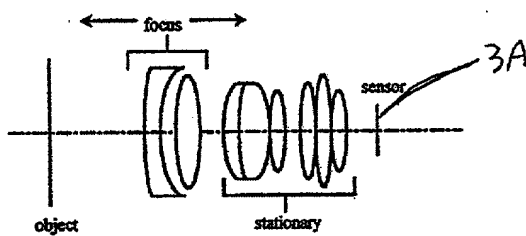


FIG. 1H4

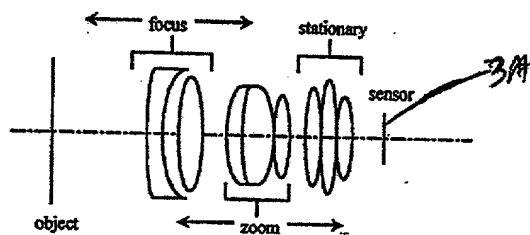
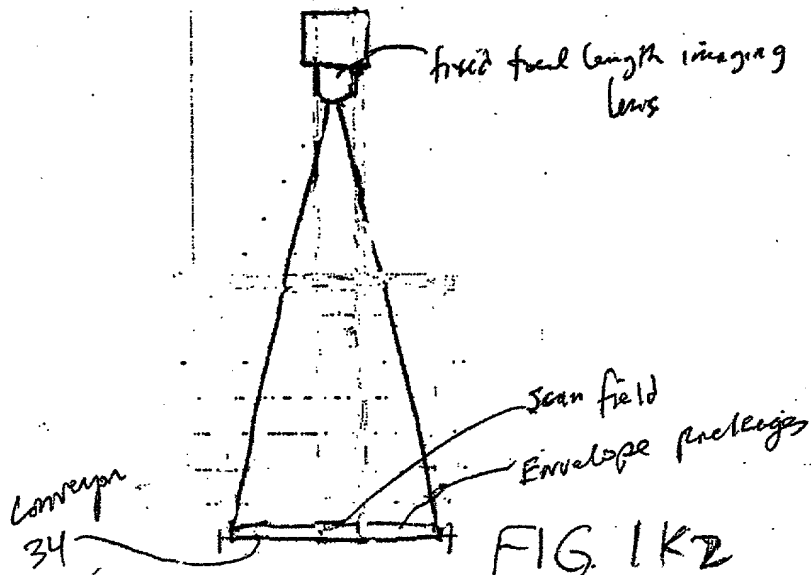
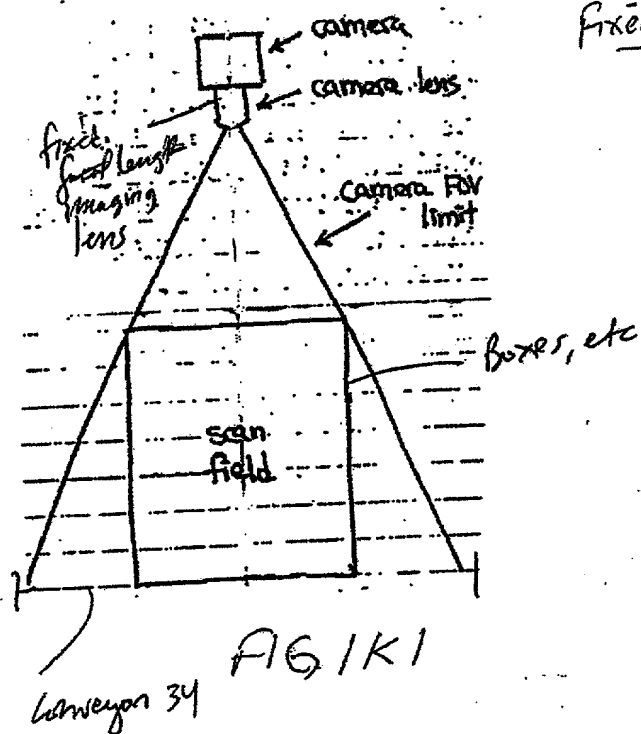


FIG. 1H5

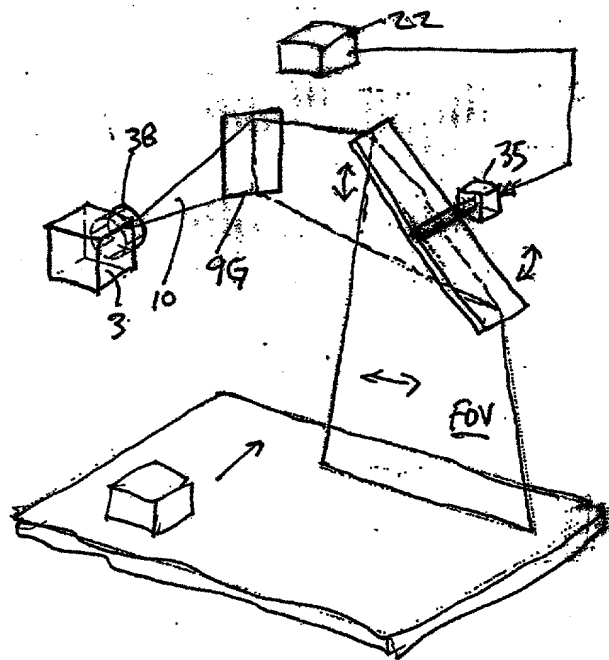
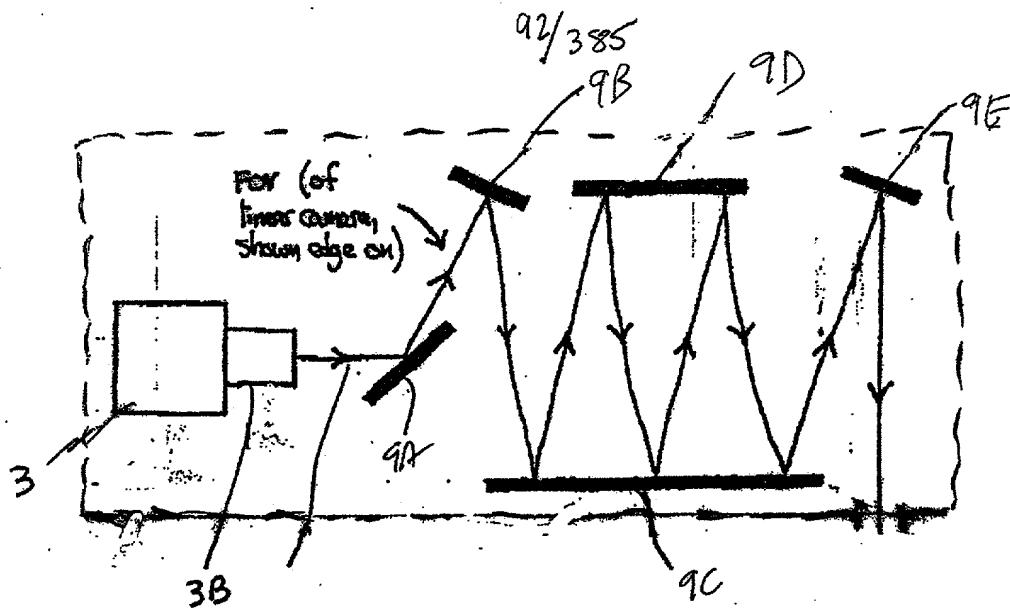
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Fixed focal length lens  
cases



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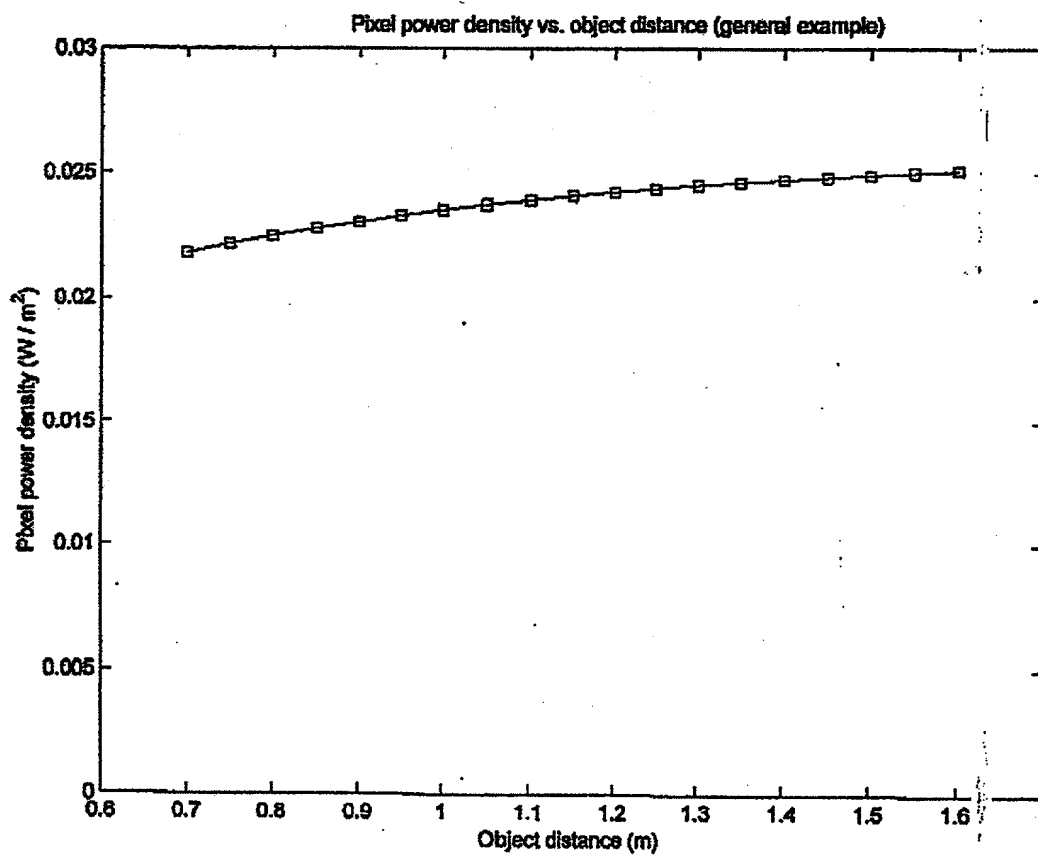


FIG-1M1

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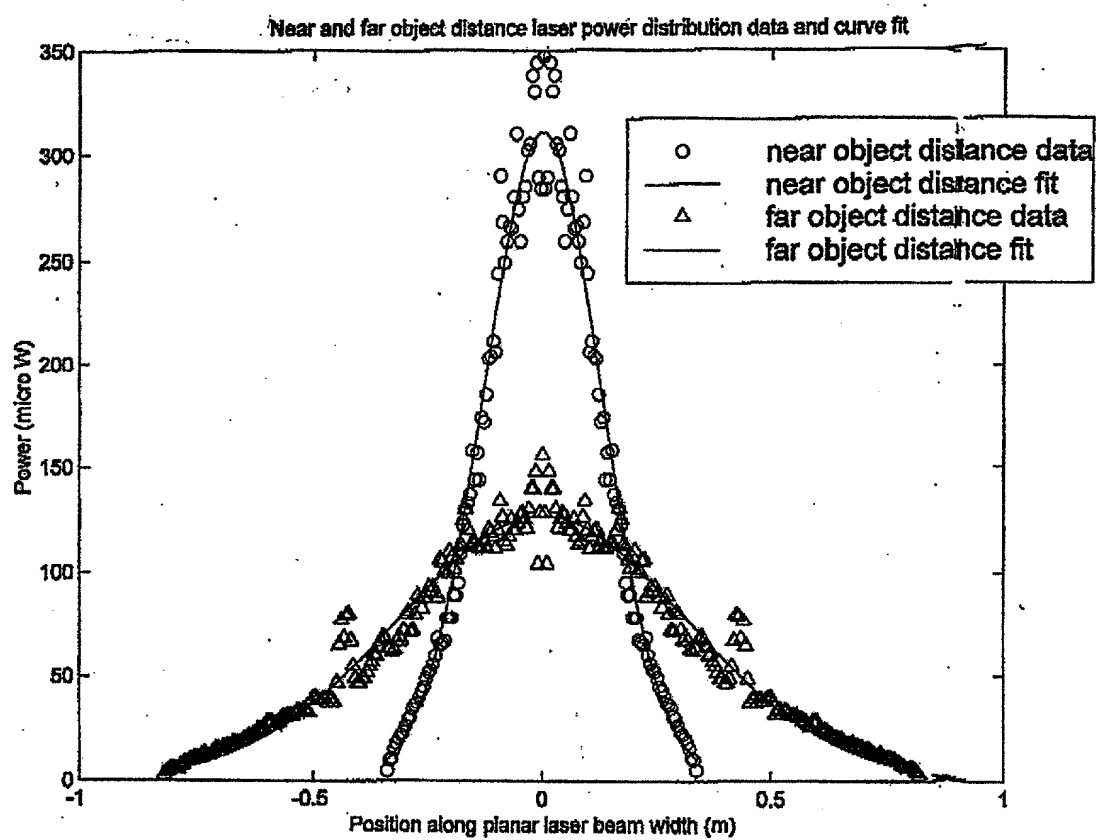


FIG. 1M2

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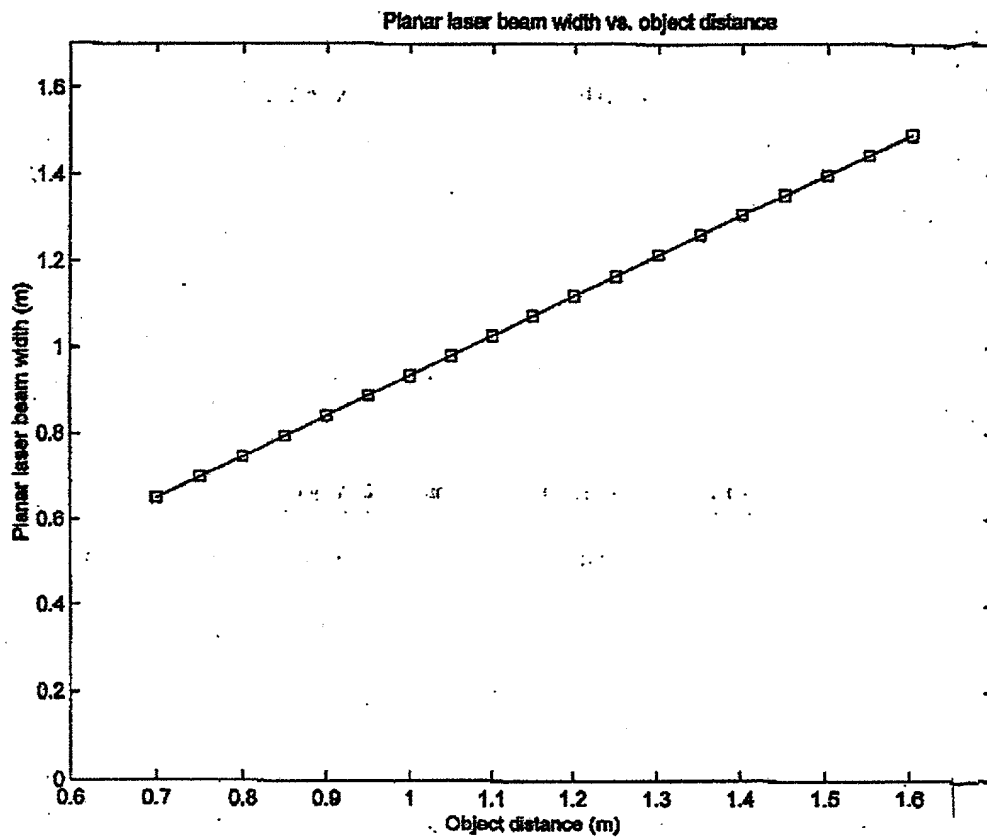


FIG. 1M3

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Figure 4: Planar laser beam height vs. object distance (far object distance focus)

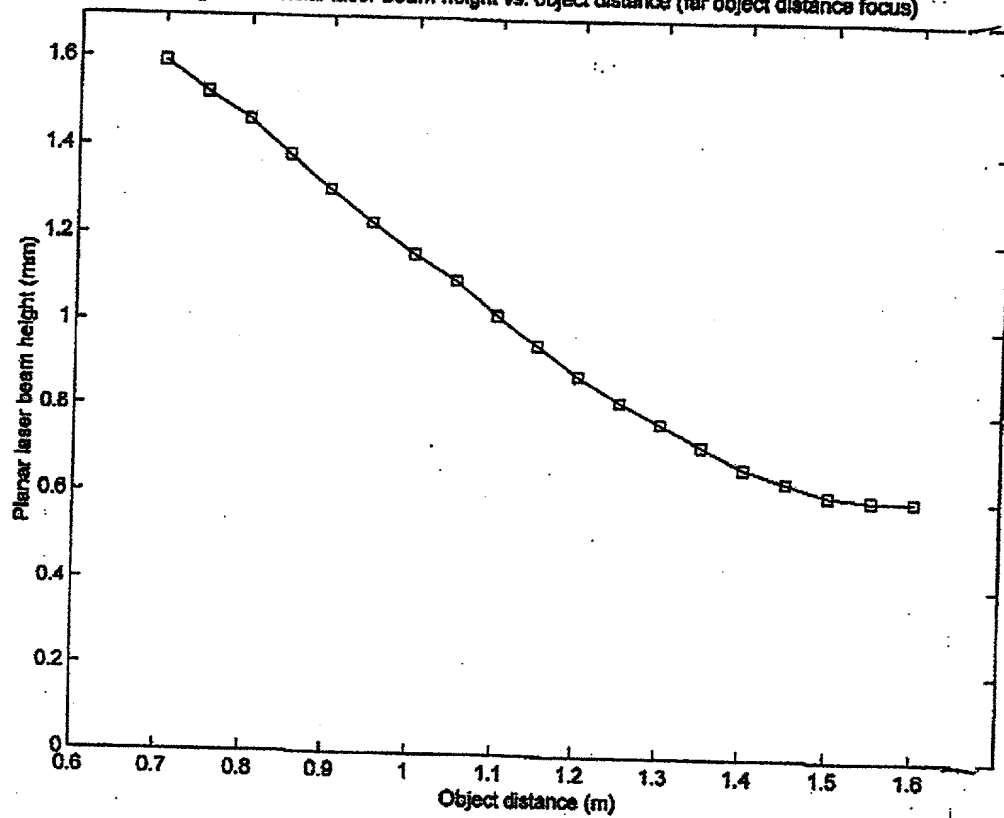


FIG. 1M4

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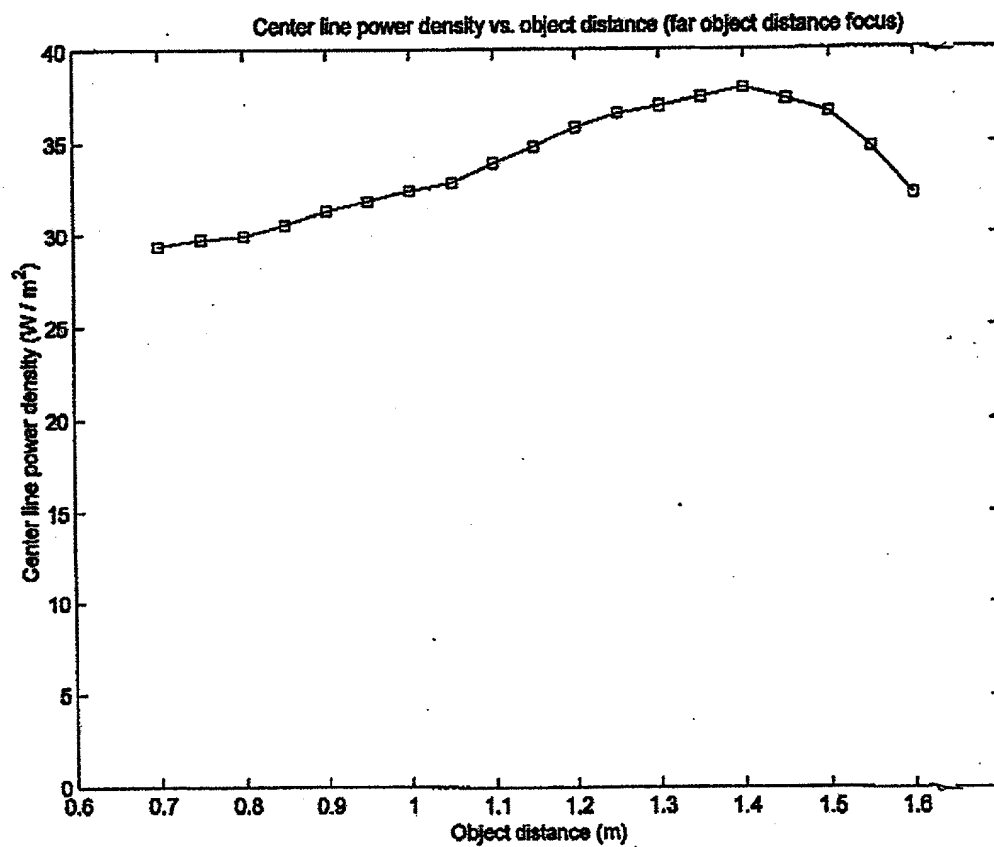


FIG. 1N

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Figure 6: Pixel power densities vs. object distance

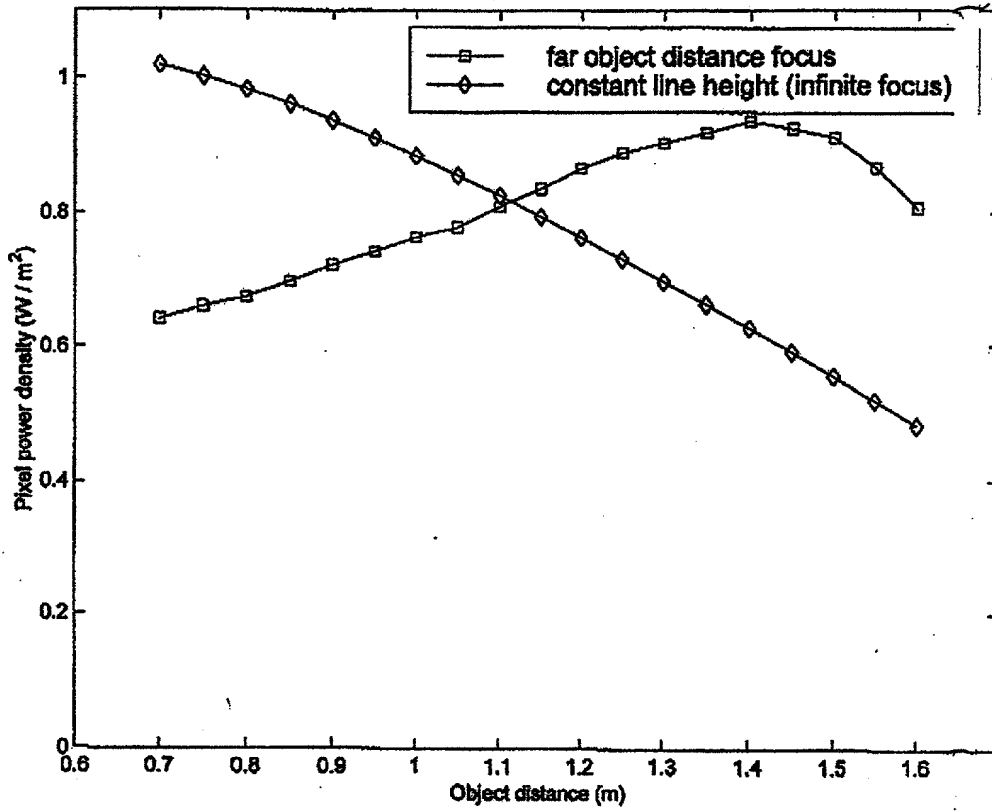
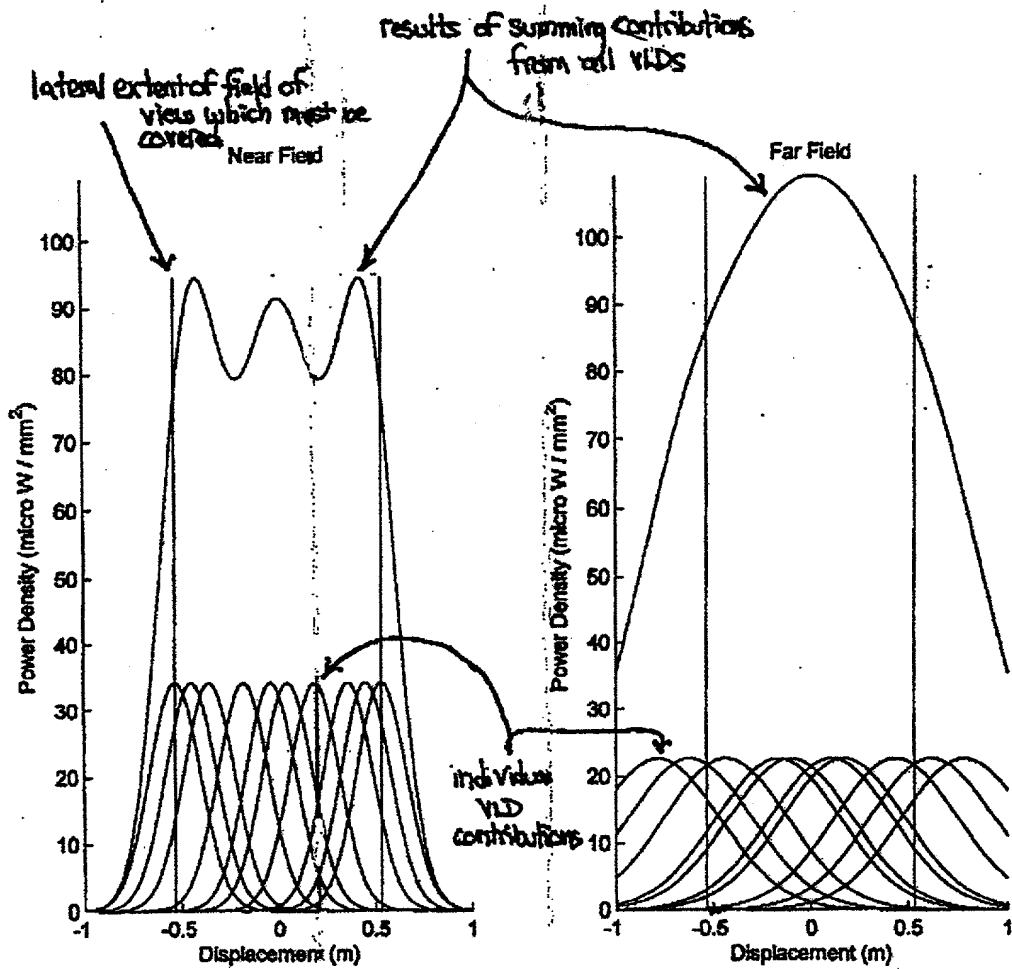


FIG. 10

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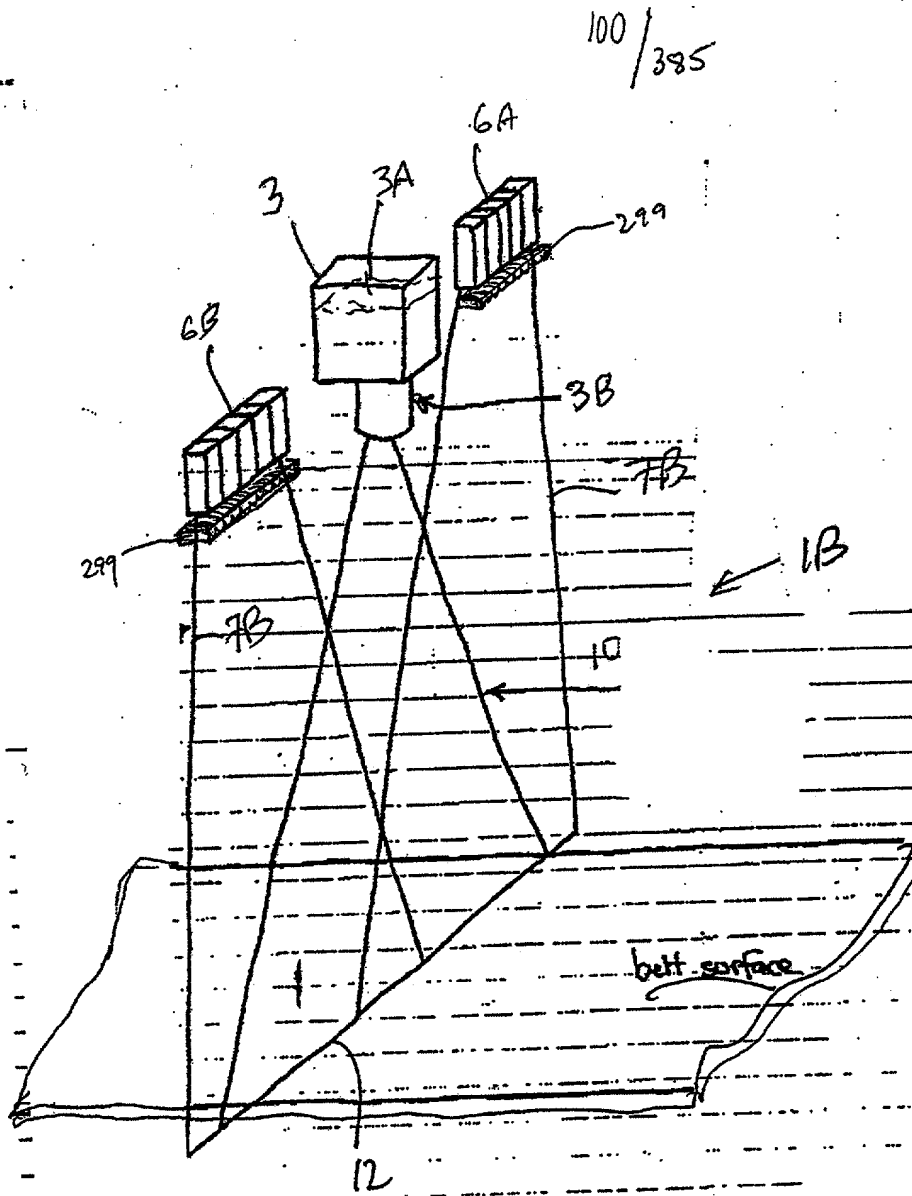


FIG. 1Q1



[illegible]

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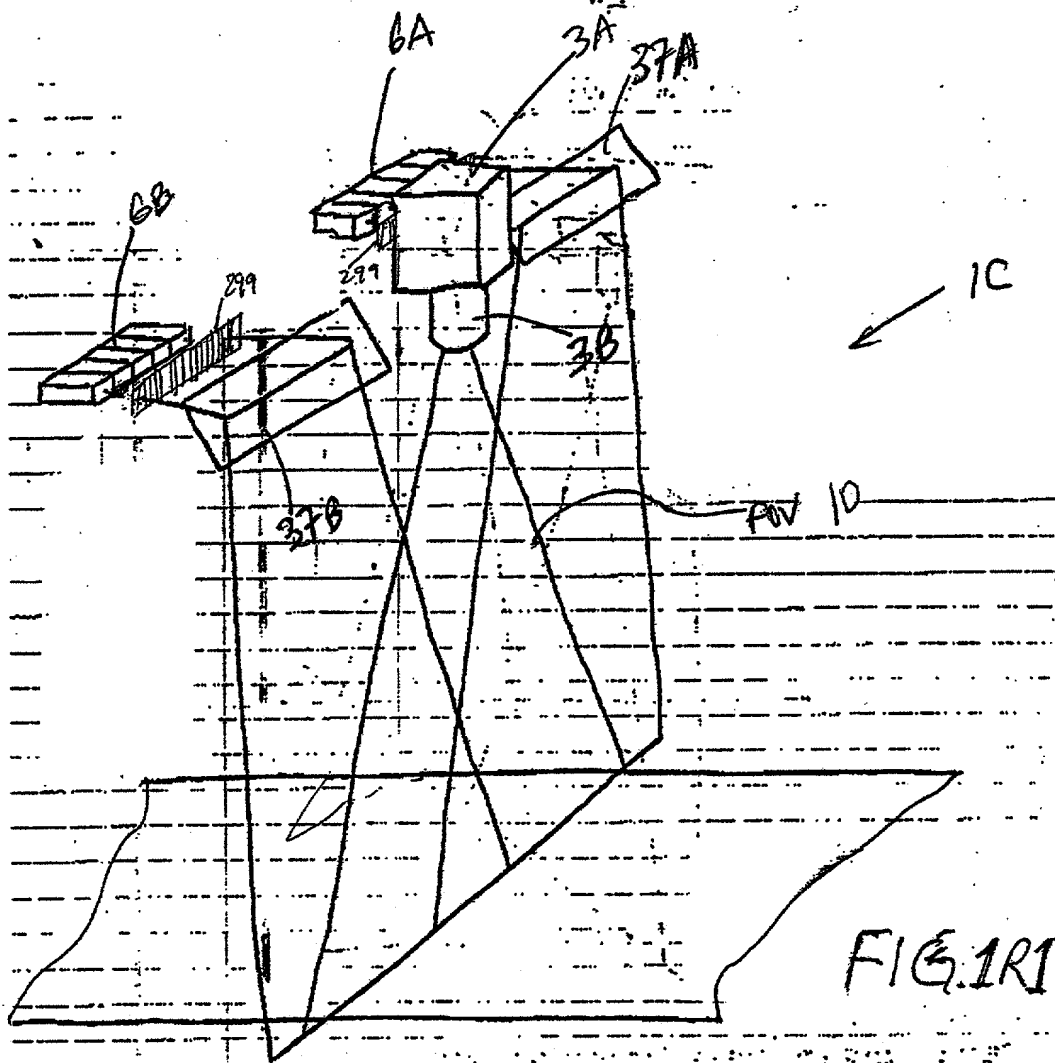


FIG. 1R1

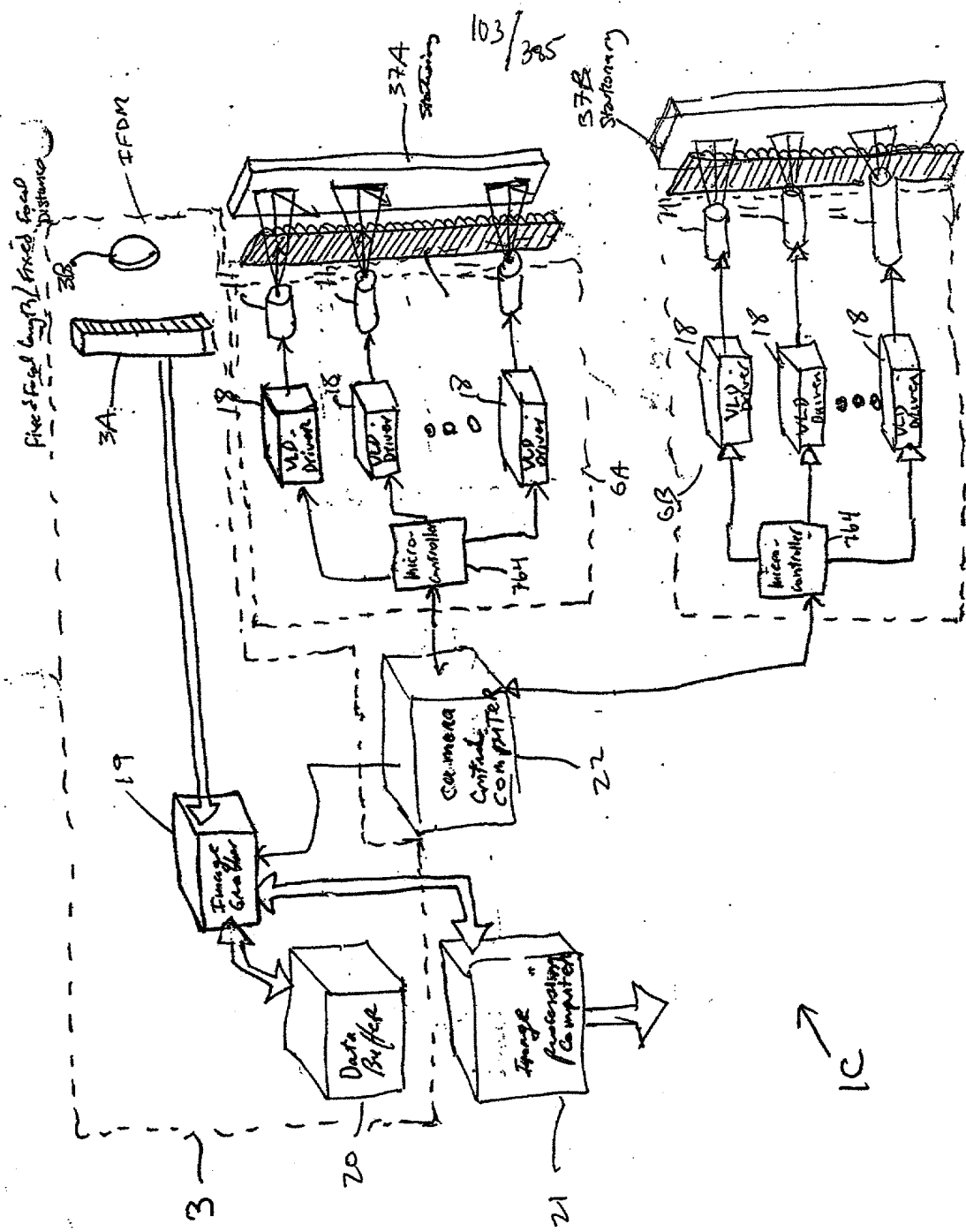


FIG. 1R2

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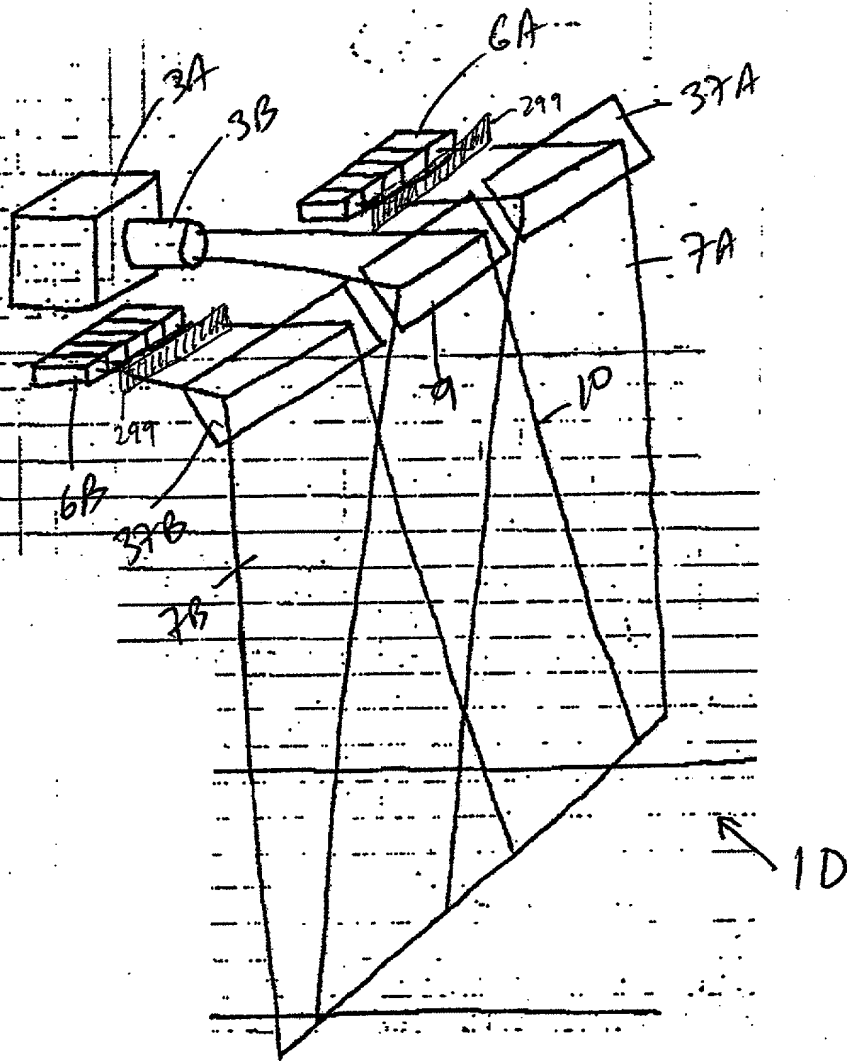


FIG. 1S1

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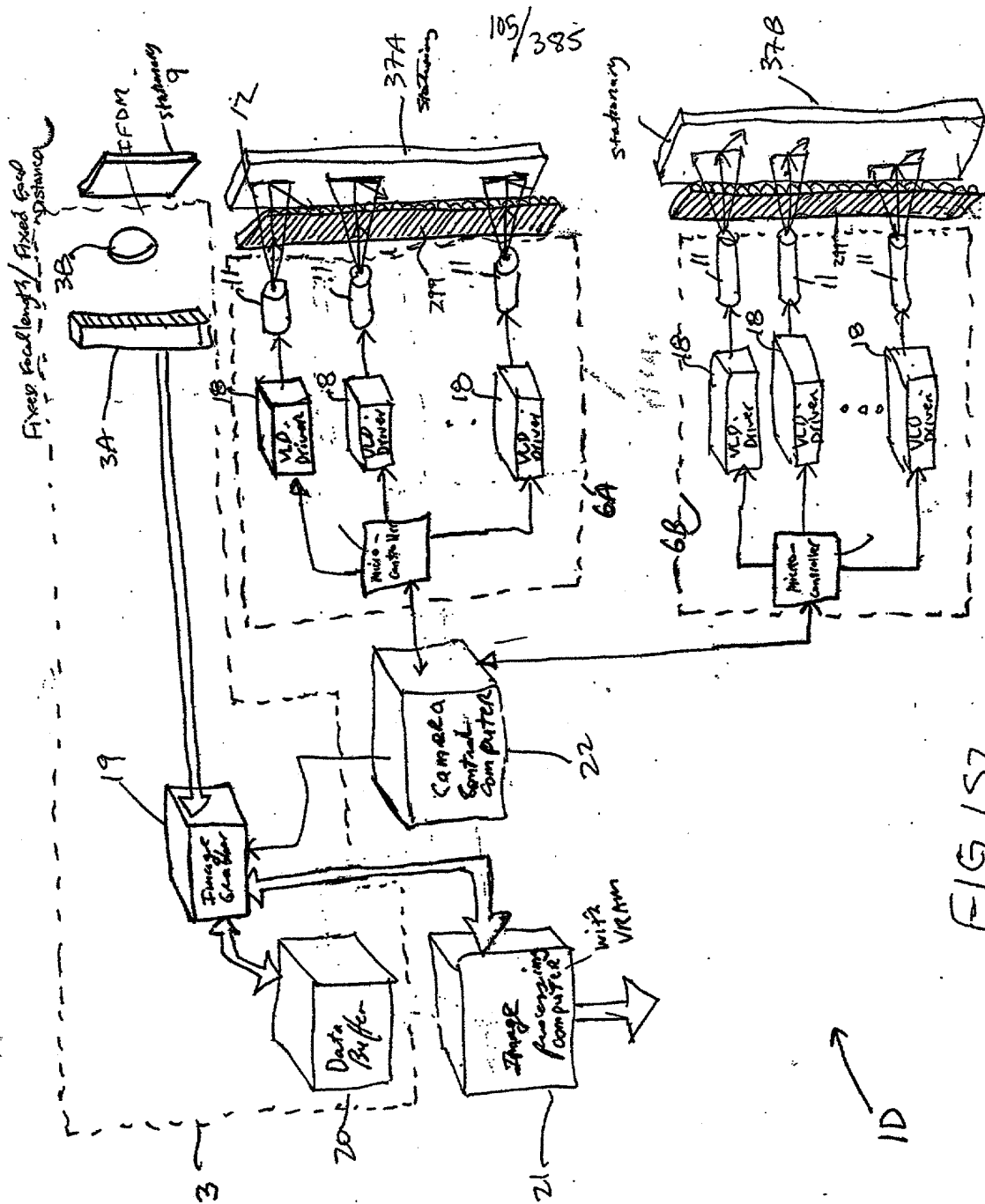


FIG. 152

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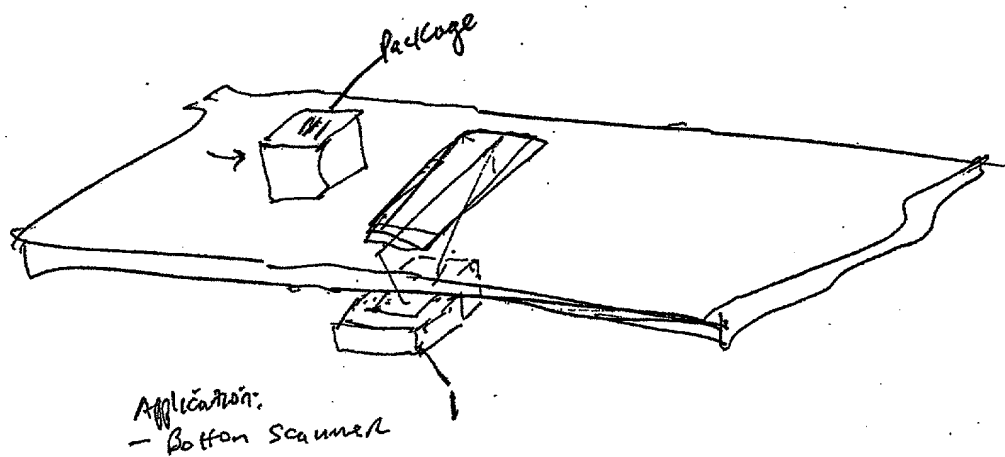
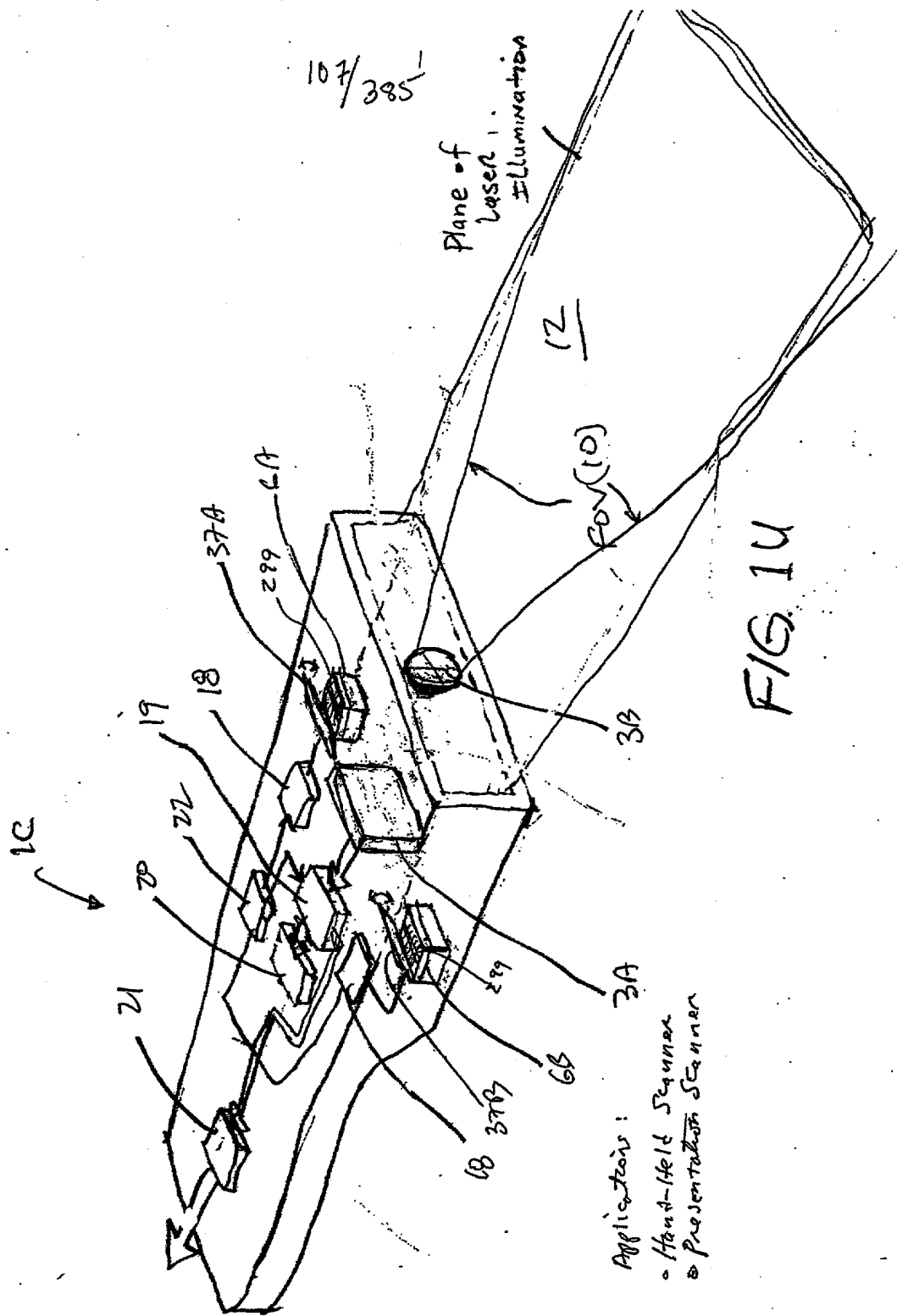


FIG 1T



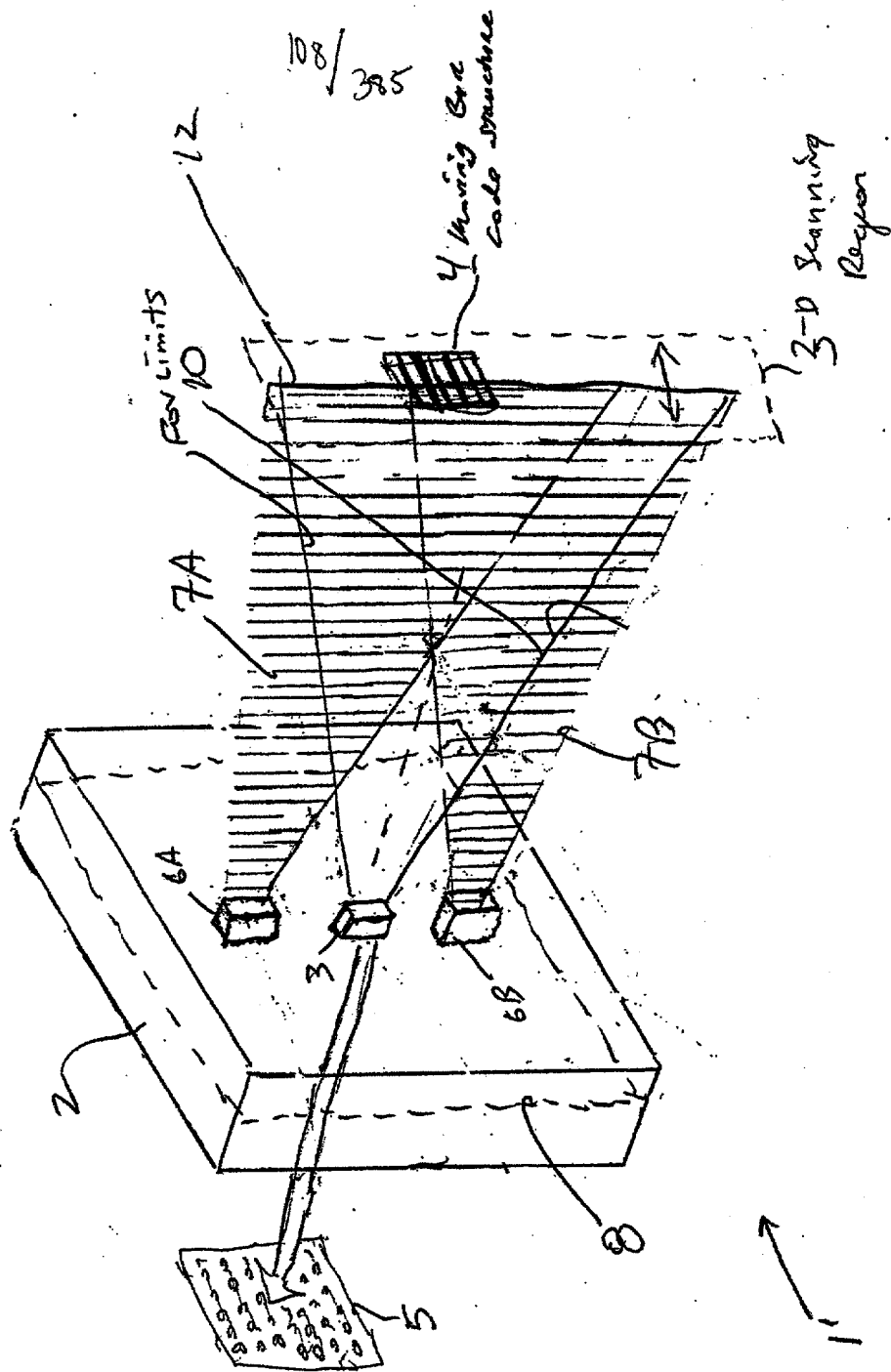


FIG. 1VI



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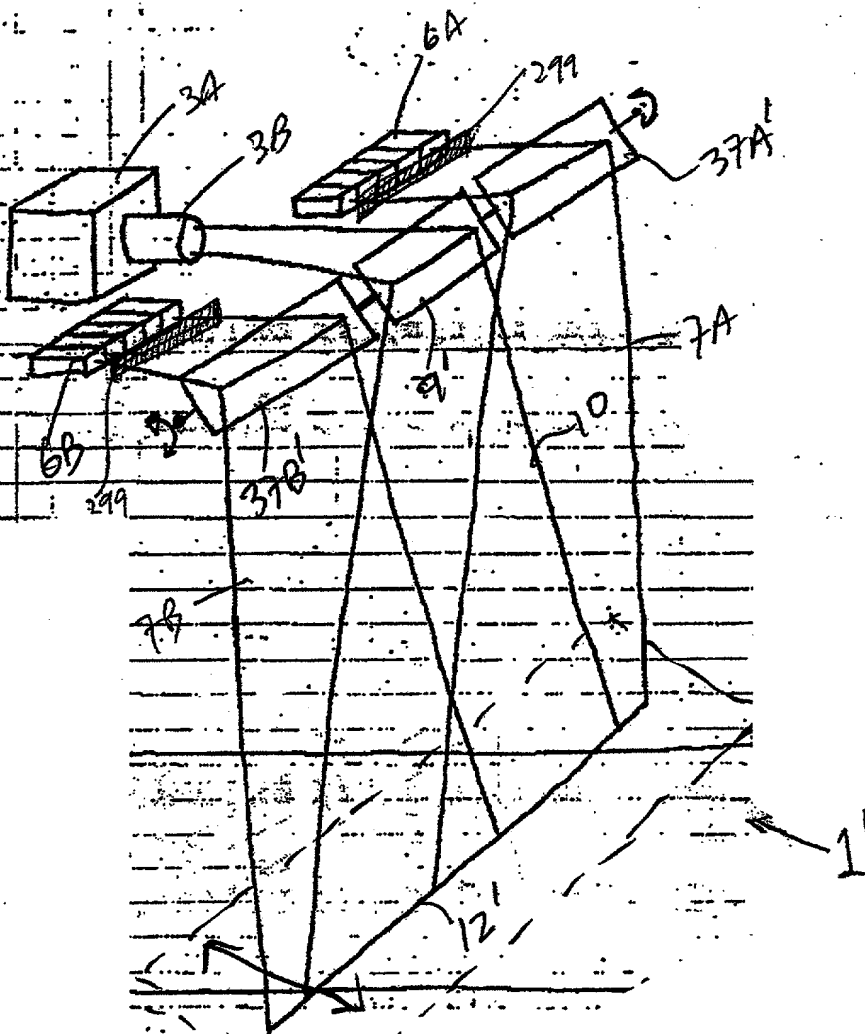
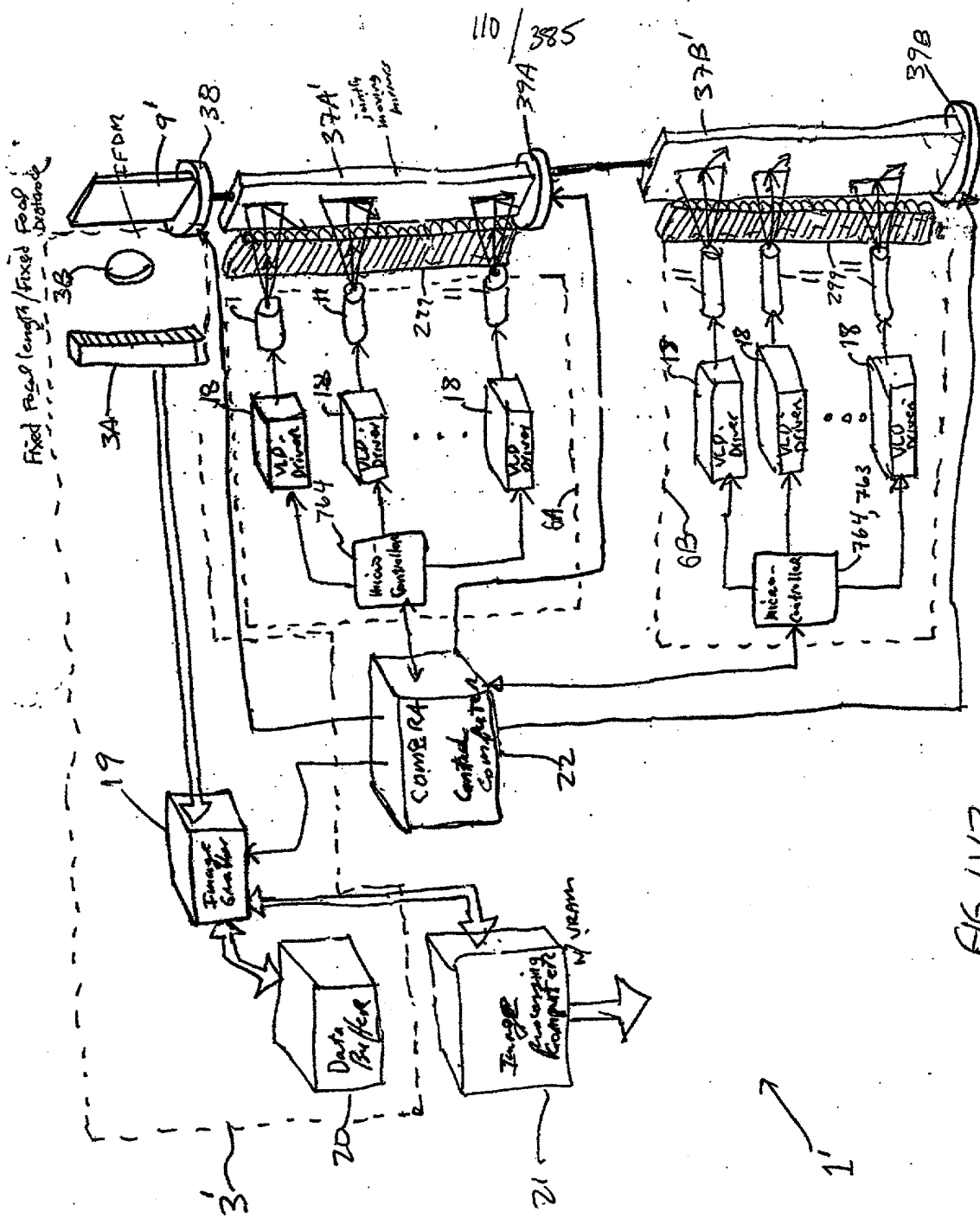


FIG. IV2

3-D  
region  
space

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THE UNIVERSITY OF CHICAGO



AG.1V3

(

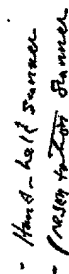


FIG. 1V4

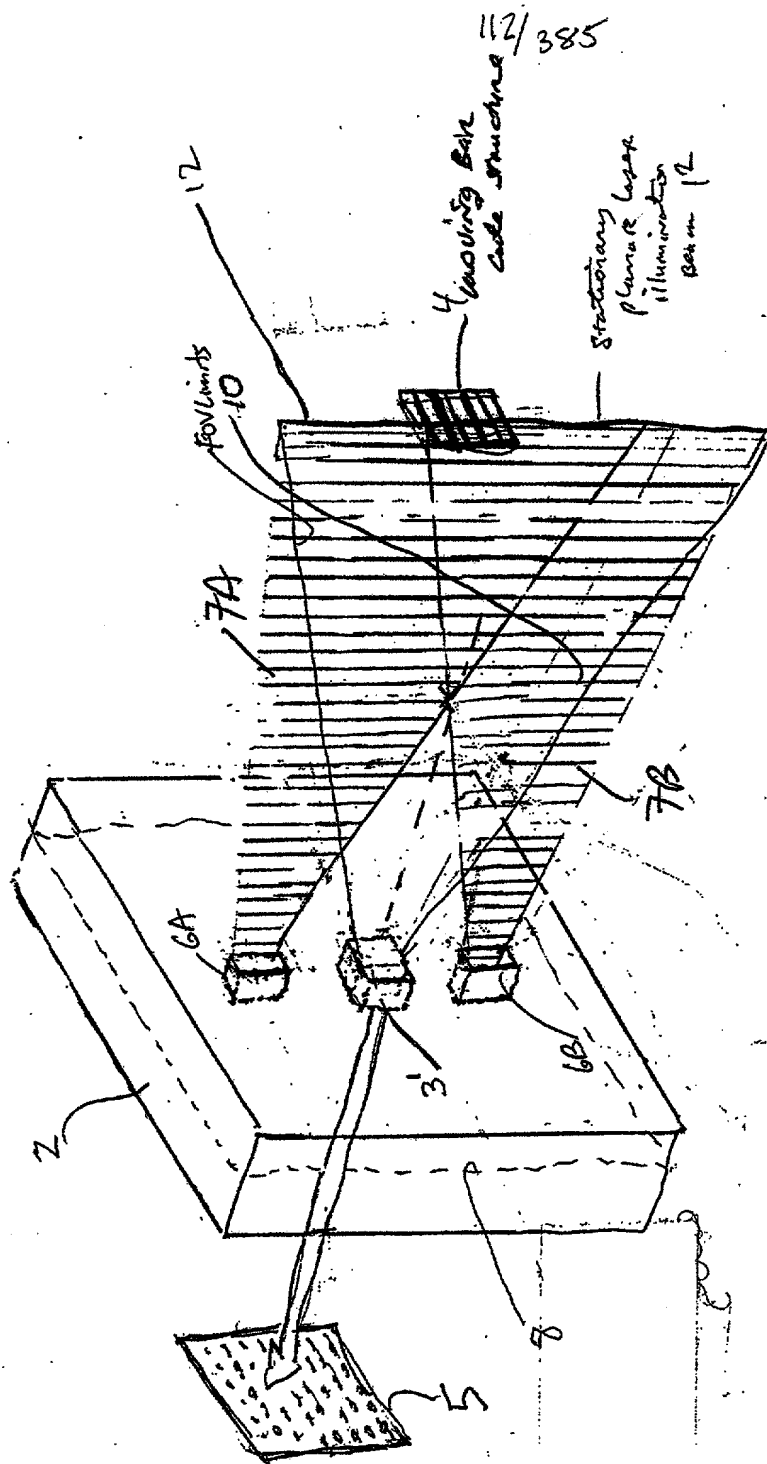


FIG. 2A

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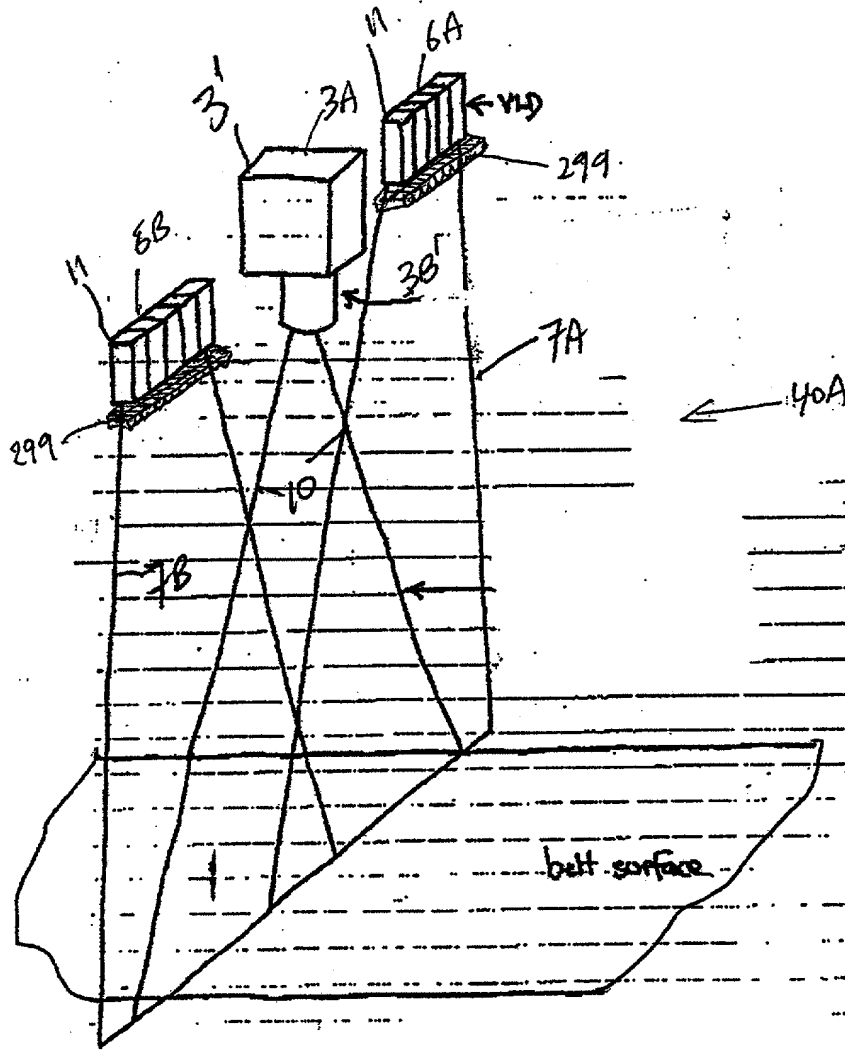
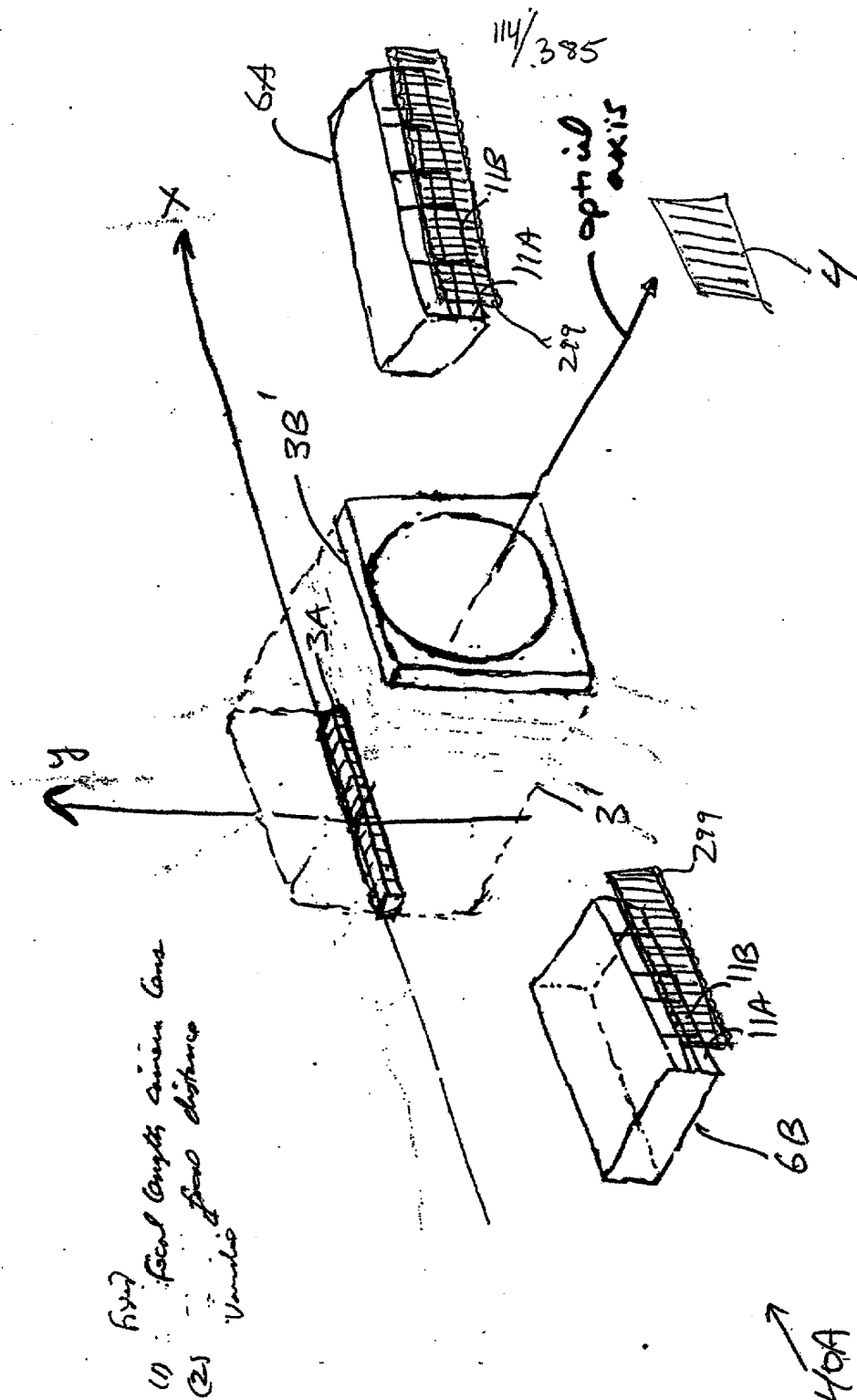
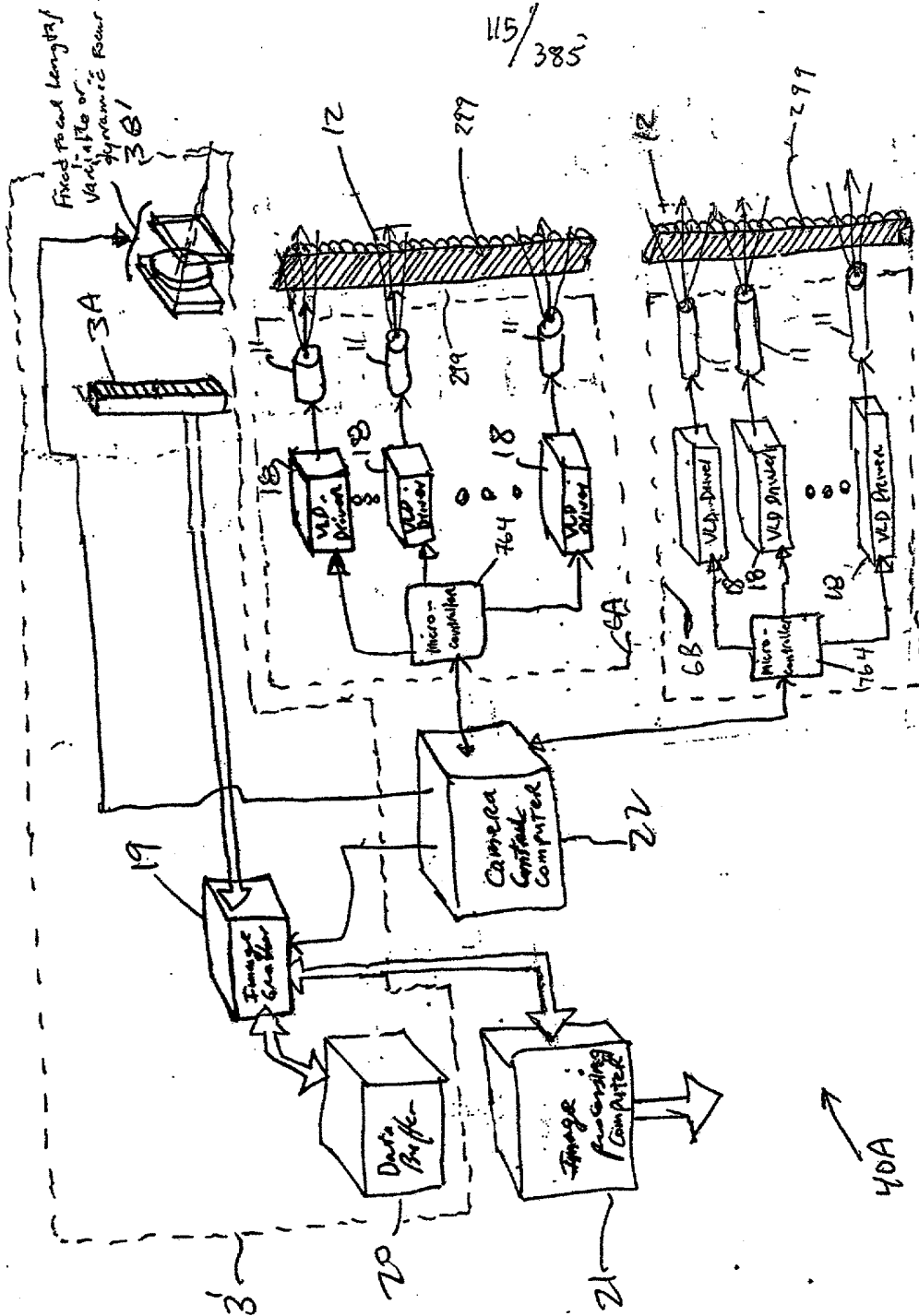


FIG. 2 B1



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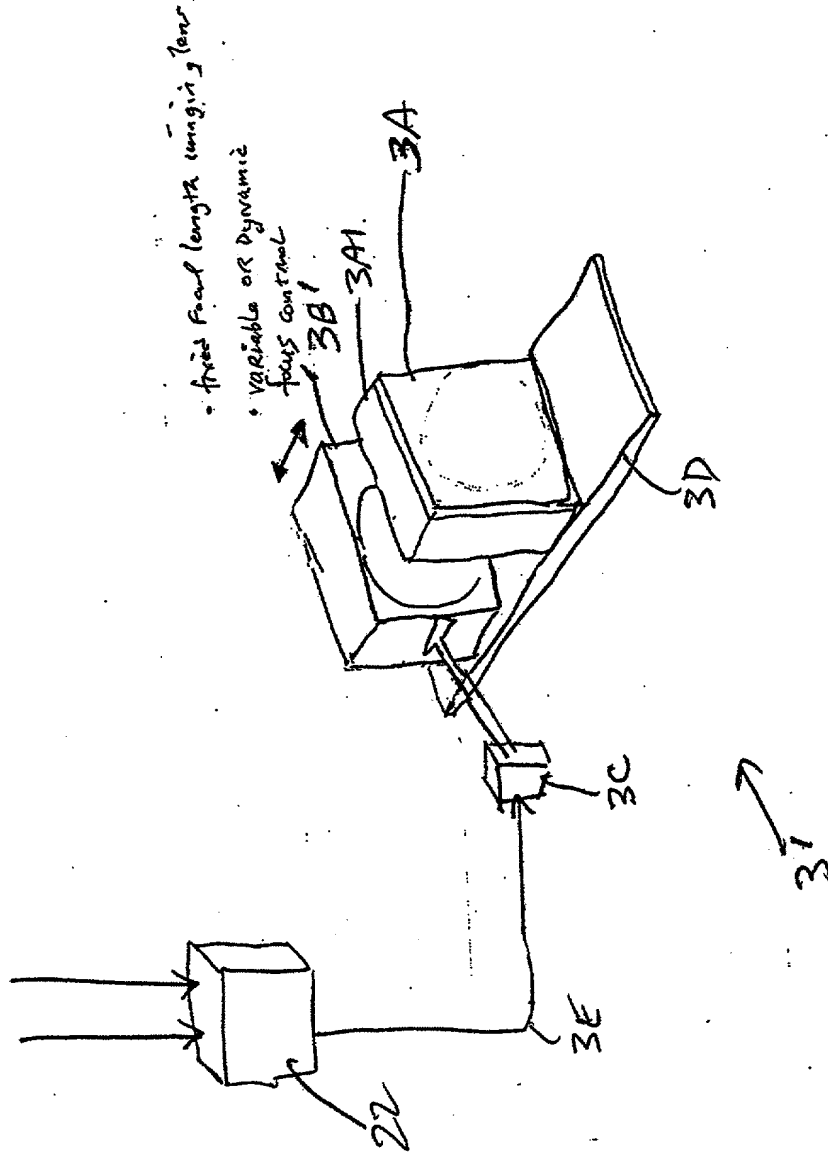


FIG. 2C2



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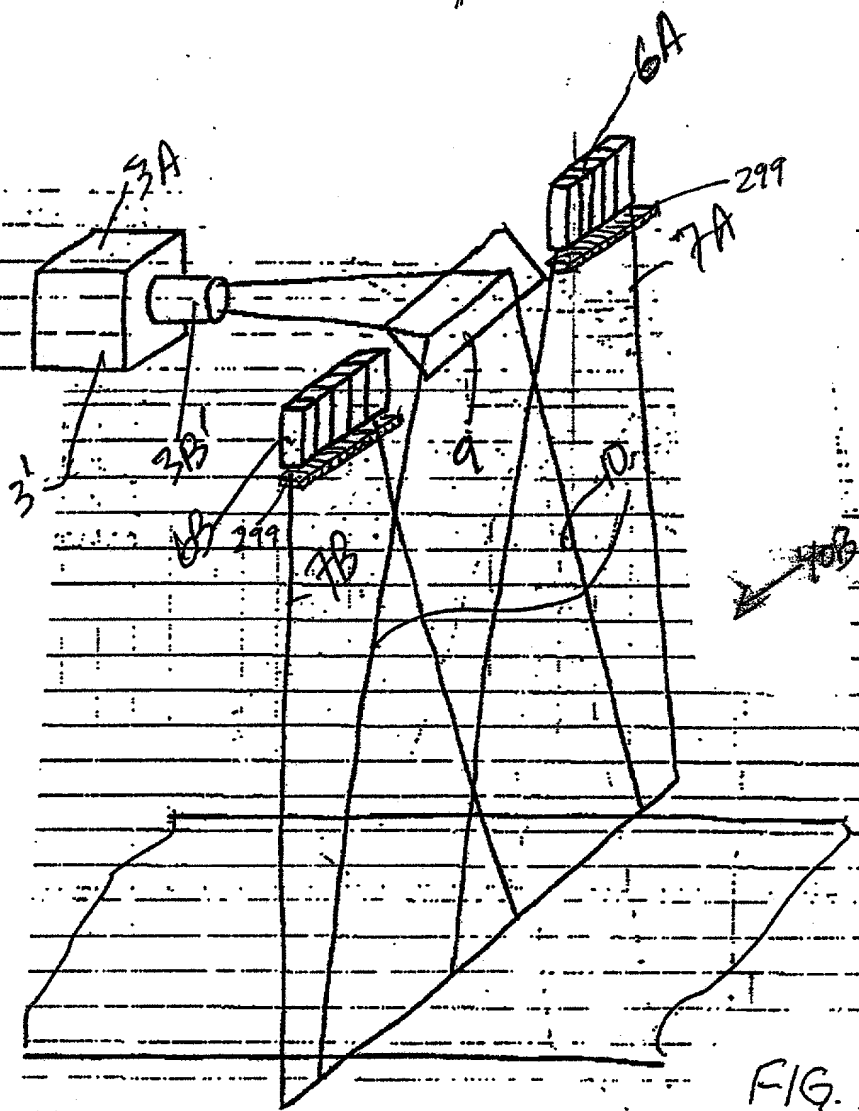


FIG. 2D1

1066462.020702



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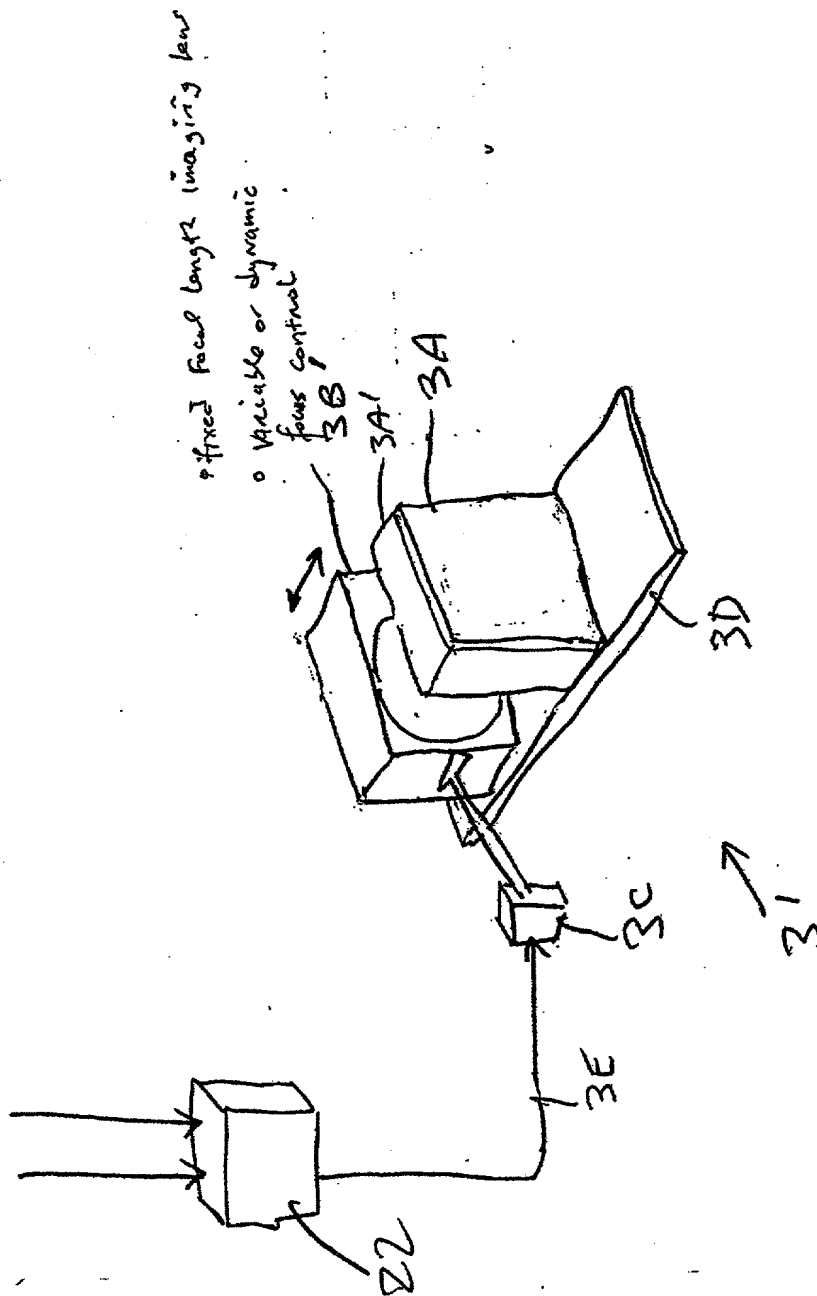


FIG. 2D3

10068462.020702

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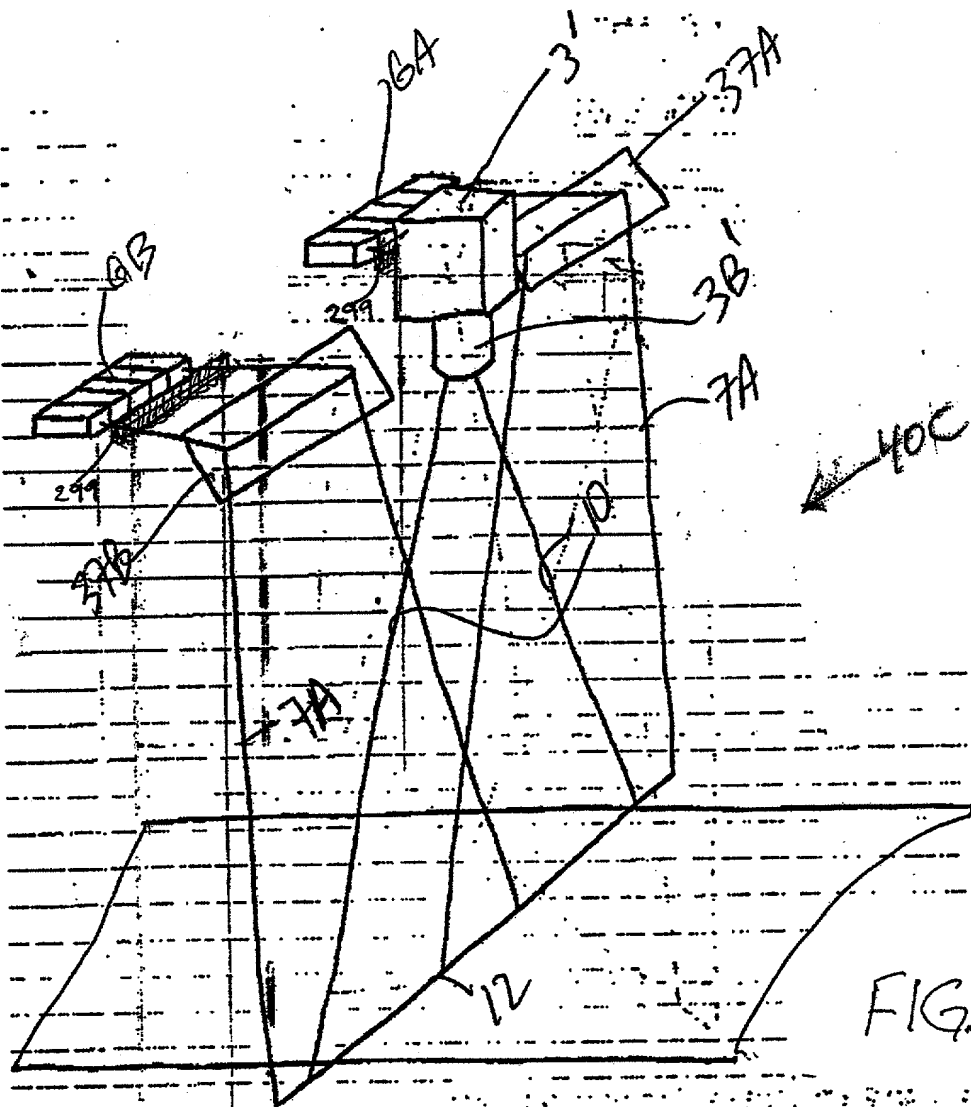


FIG. 2E1

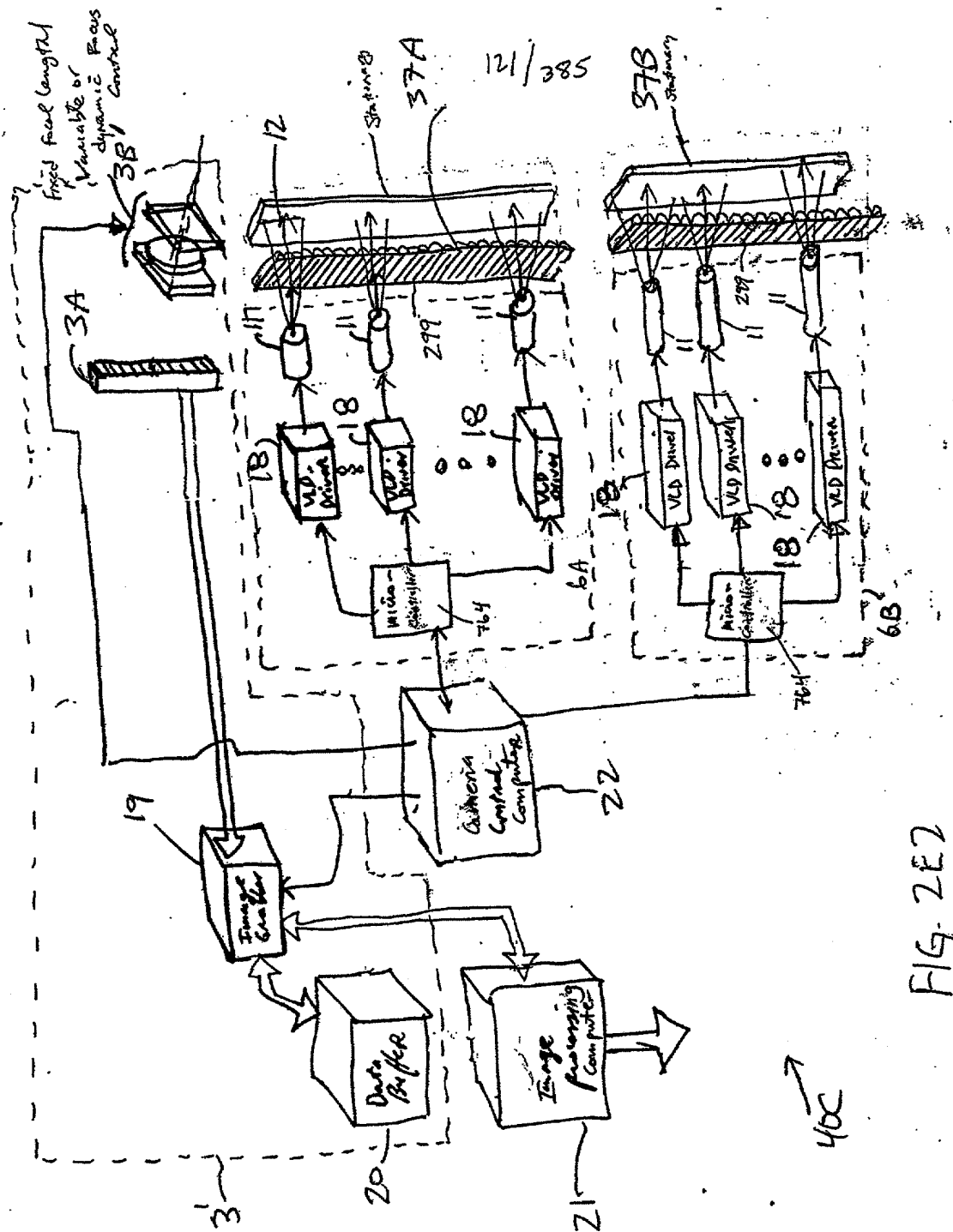


FIG. 2E2

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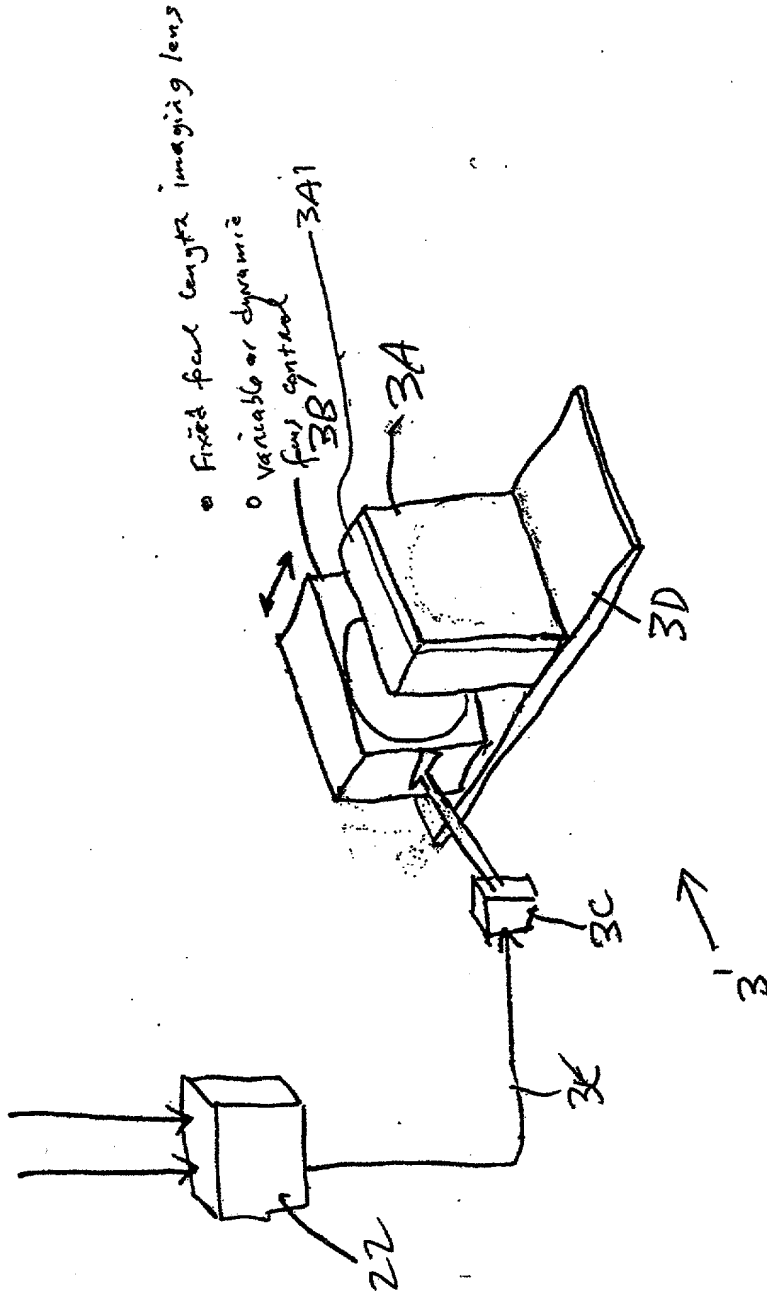
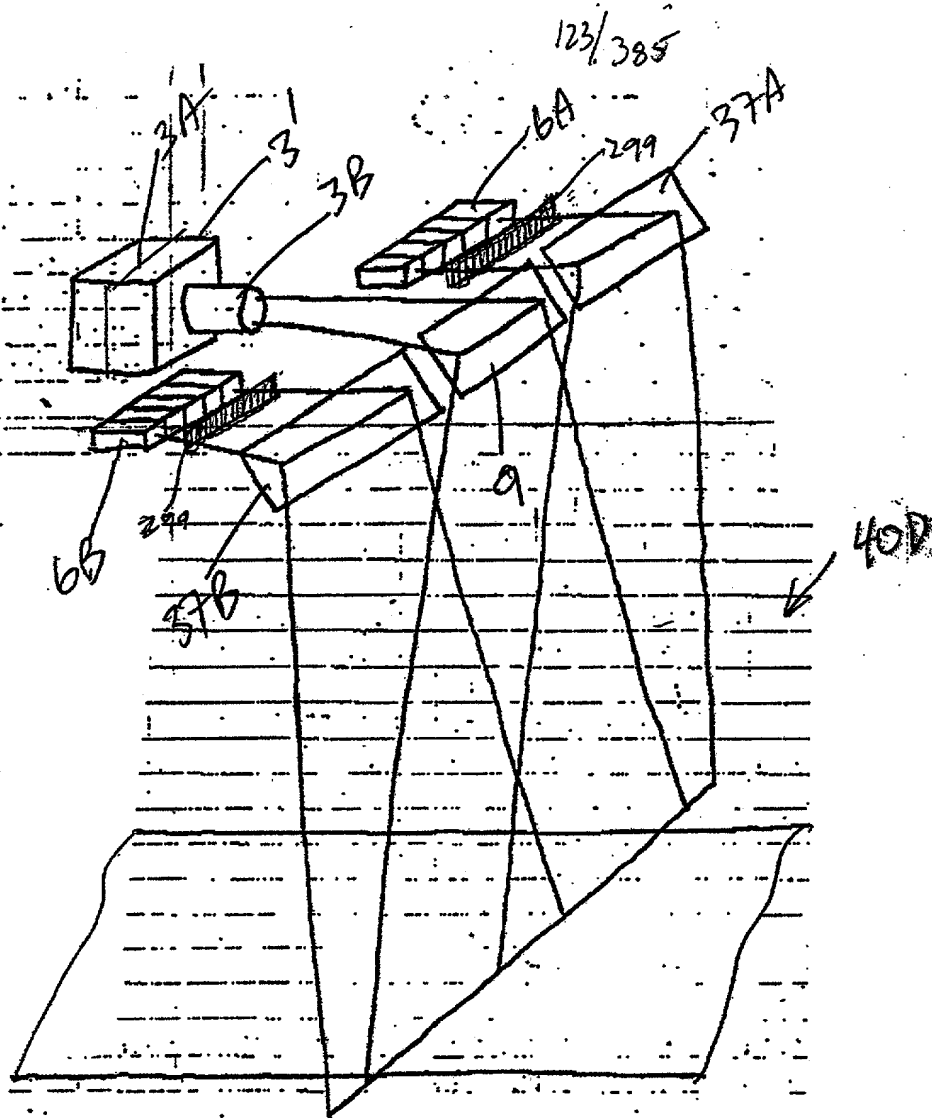
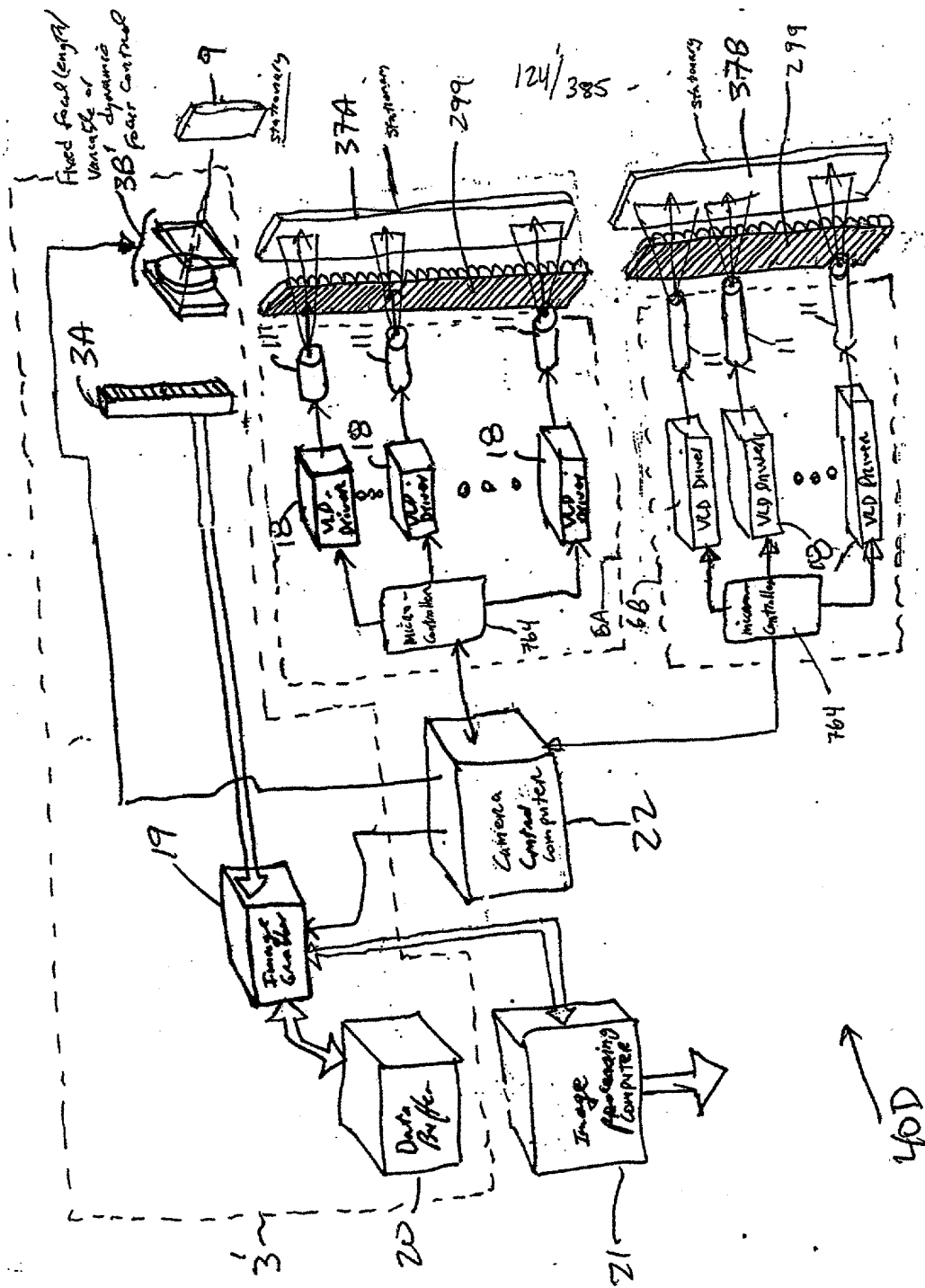


FIG. 2E3

10068452.020702







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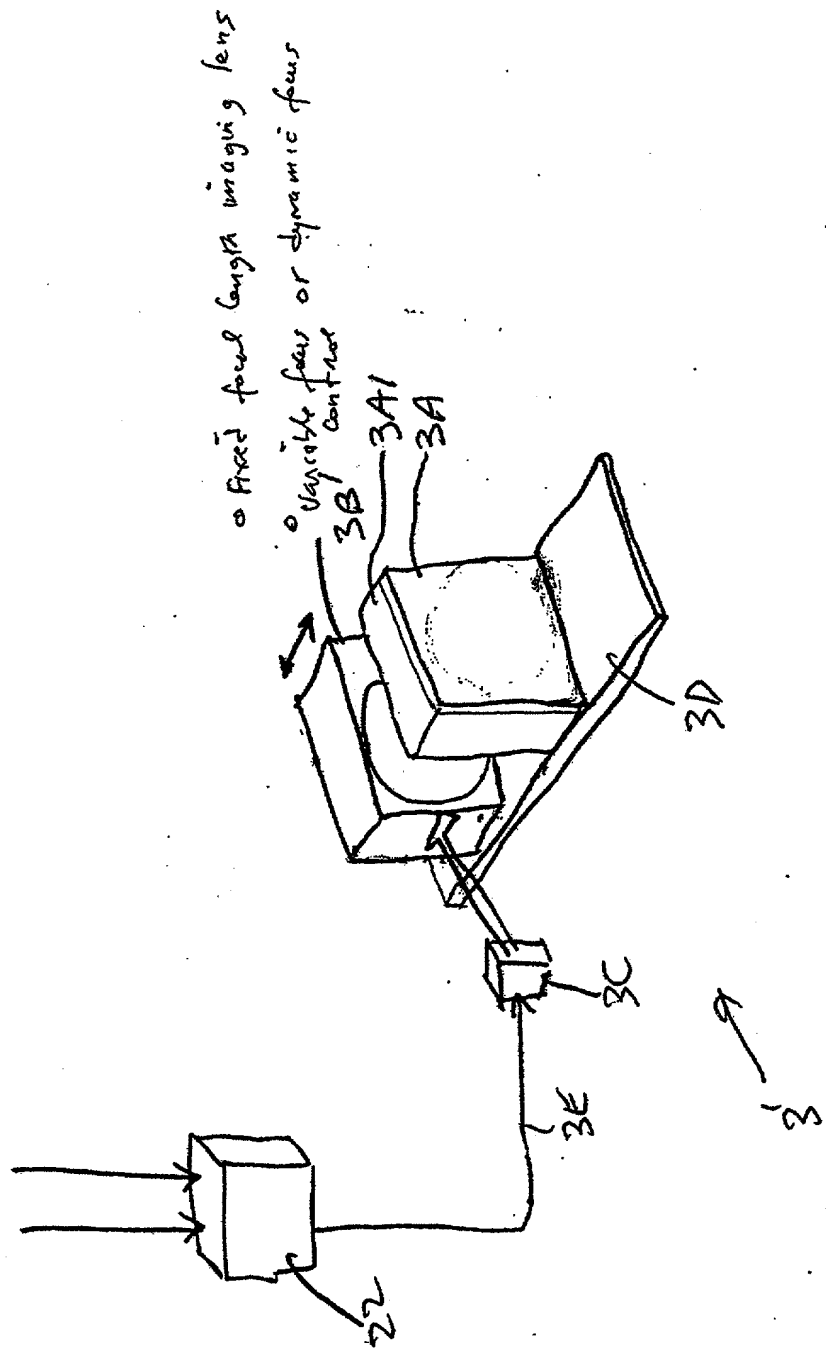


FIG. 2F3

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Top Conveyor Scanner:

- fixed focal length imaging lens
- variable focal distance control

Side Conveyor Scanner:

- fixed focal length imaging lens
- dynamic focal distance control

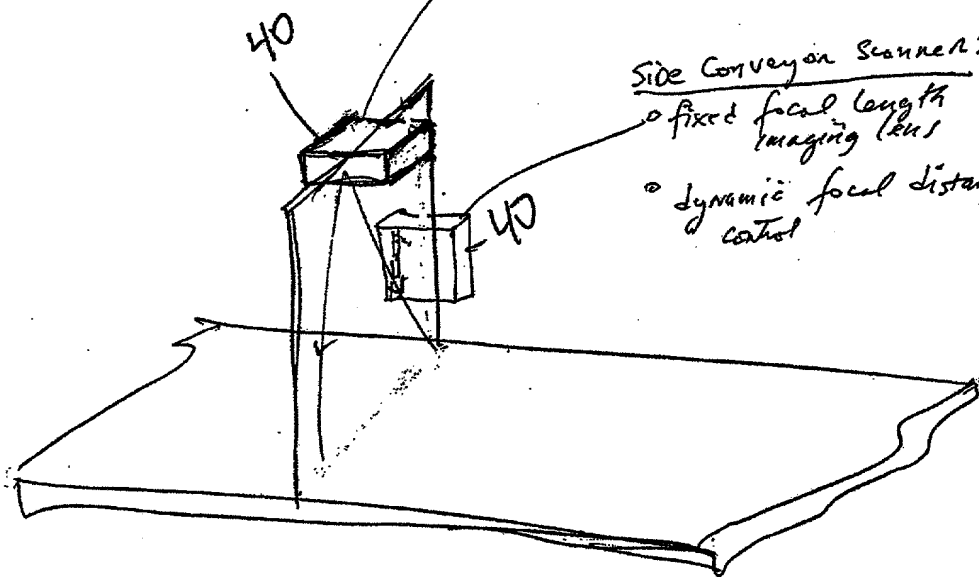


FIG. 2G

202020-2348901

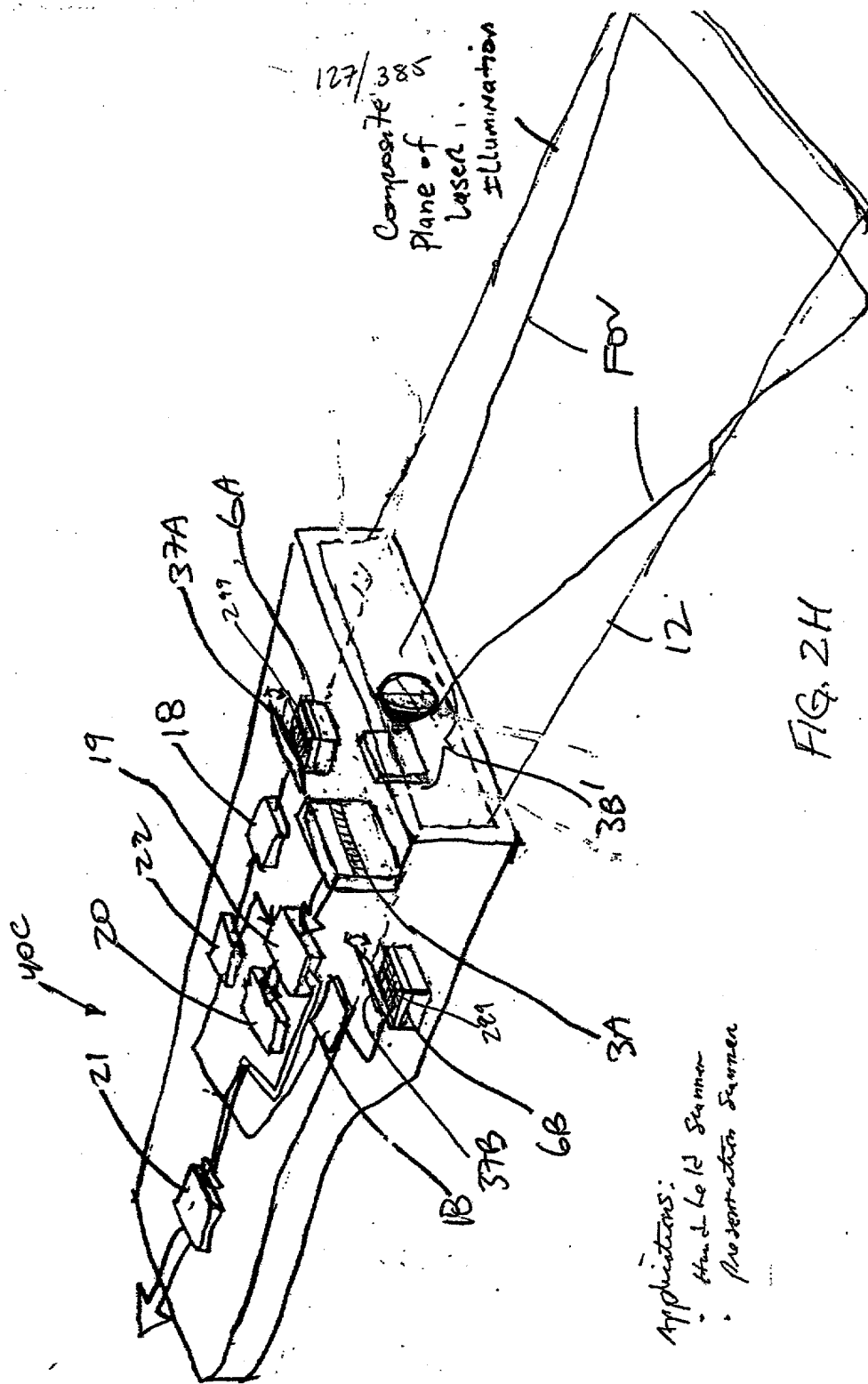


FIG. 2H



10068462.020702

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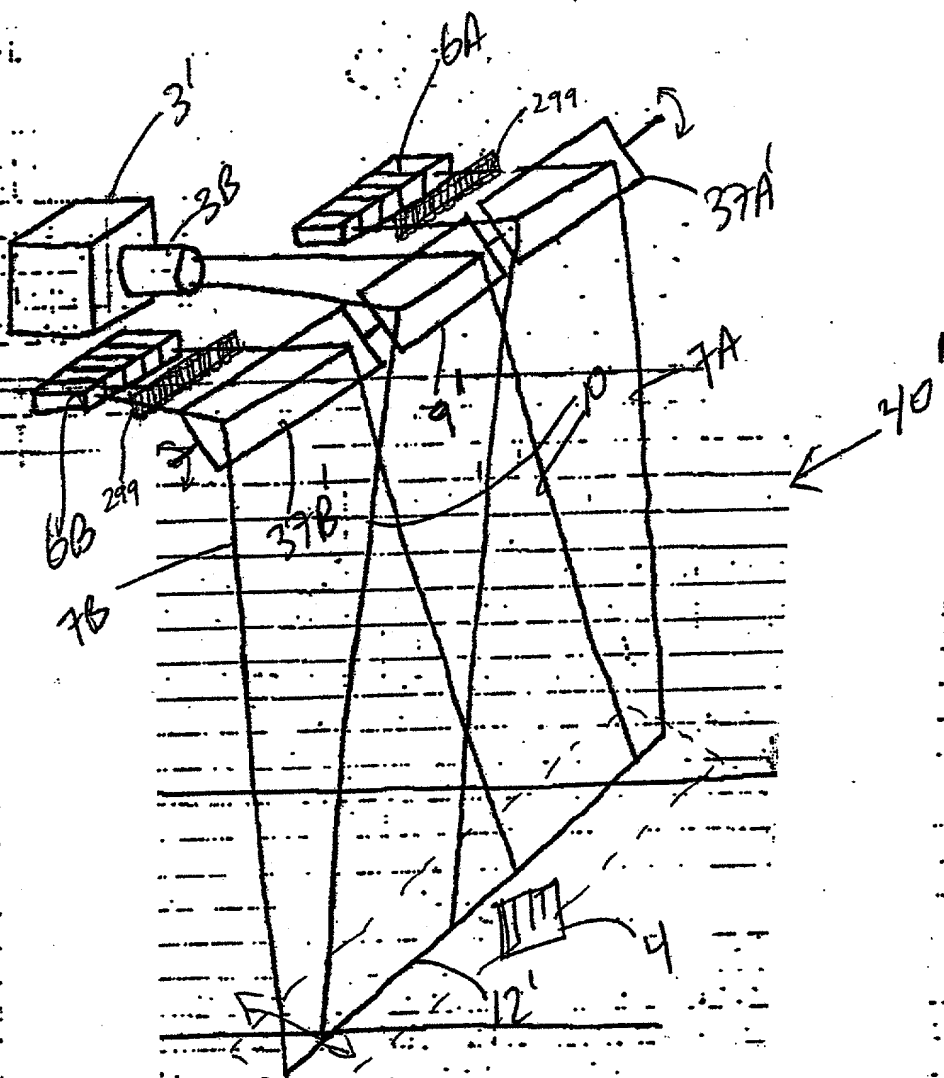


FIG 2I2

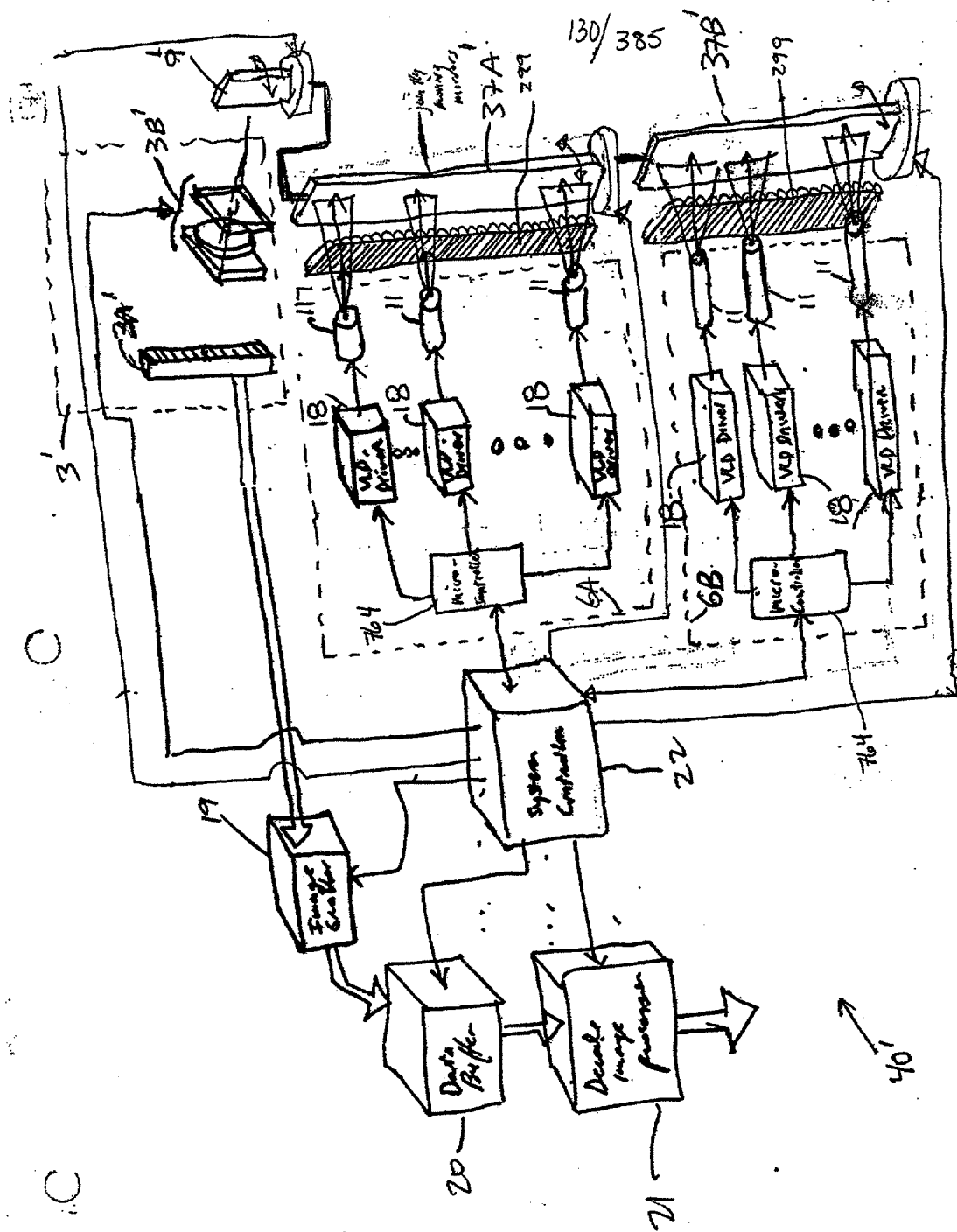
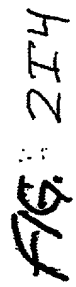


FIG. 2I3







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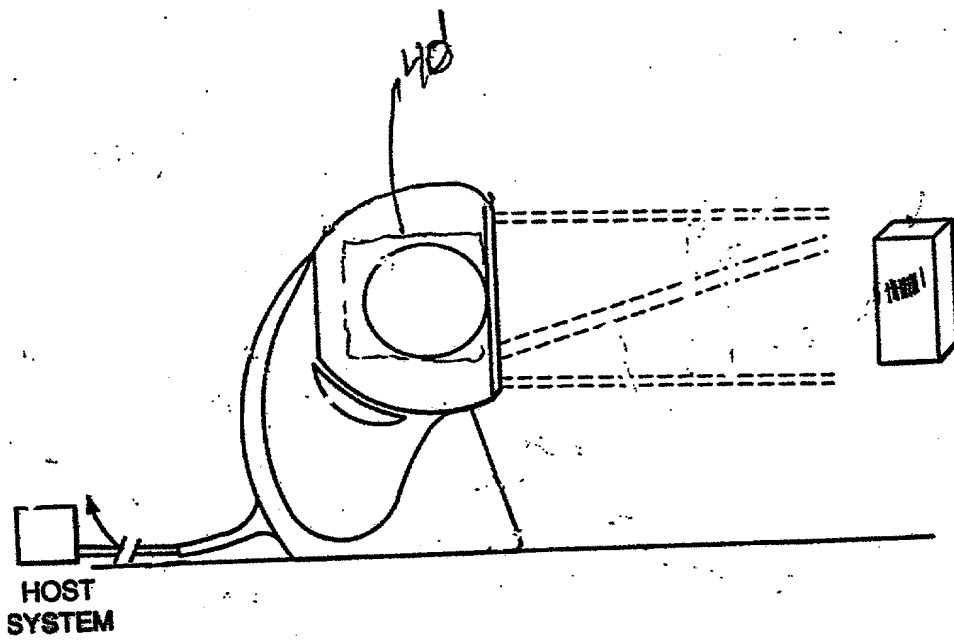


FIG. 2I6

1006463.020702

SECRET

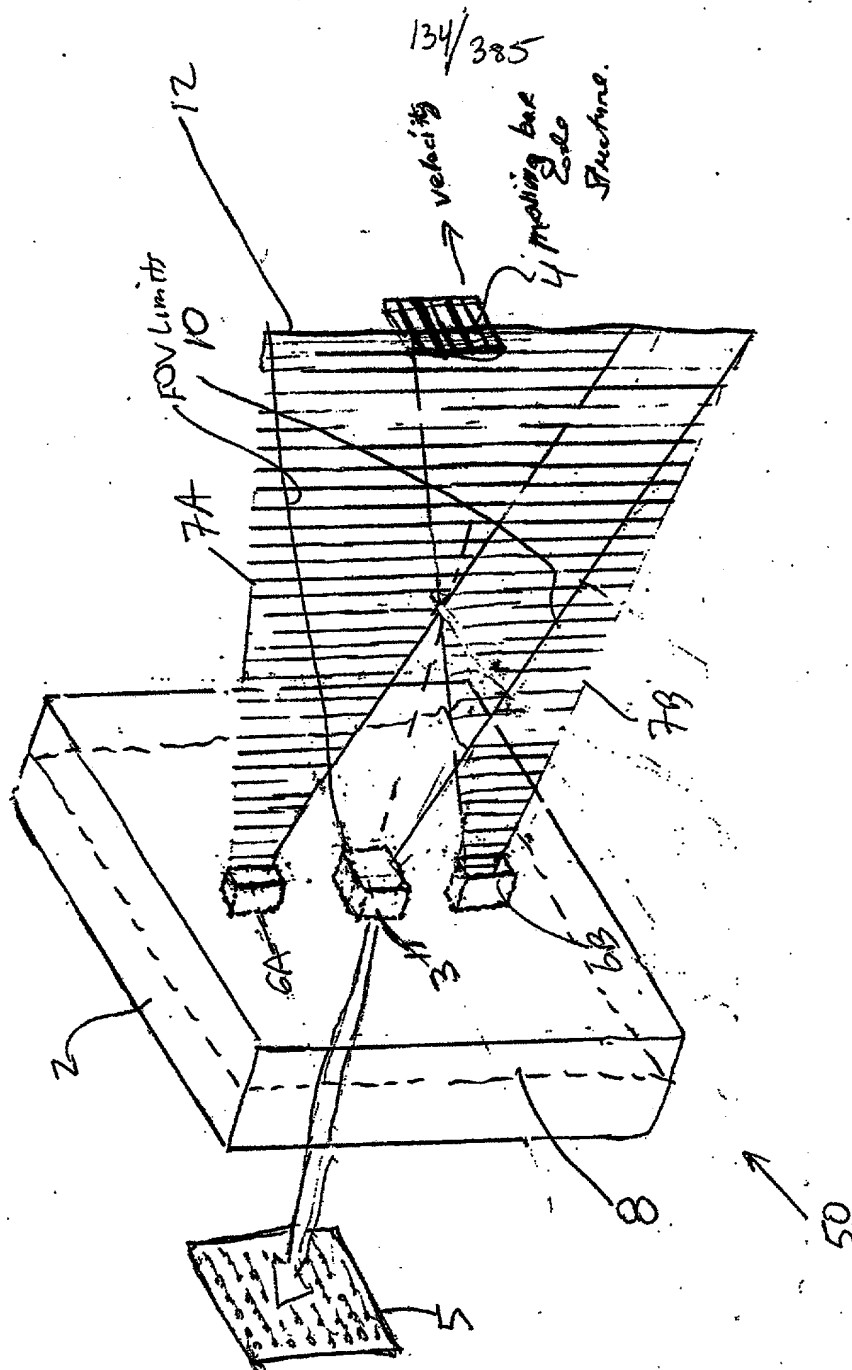


FIG 3A

10058462.020702

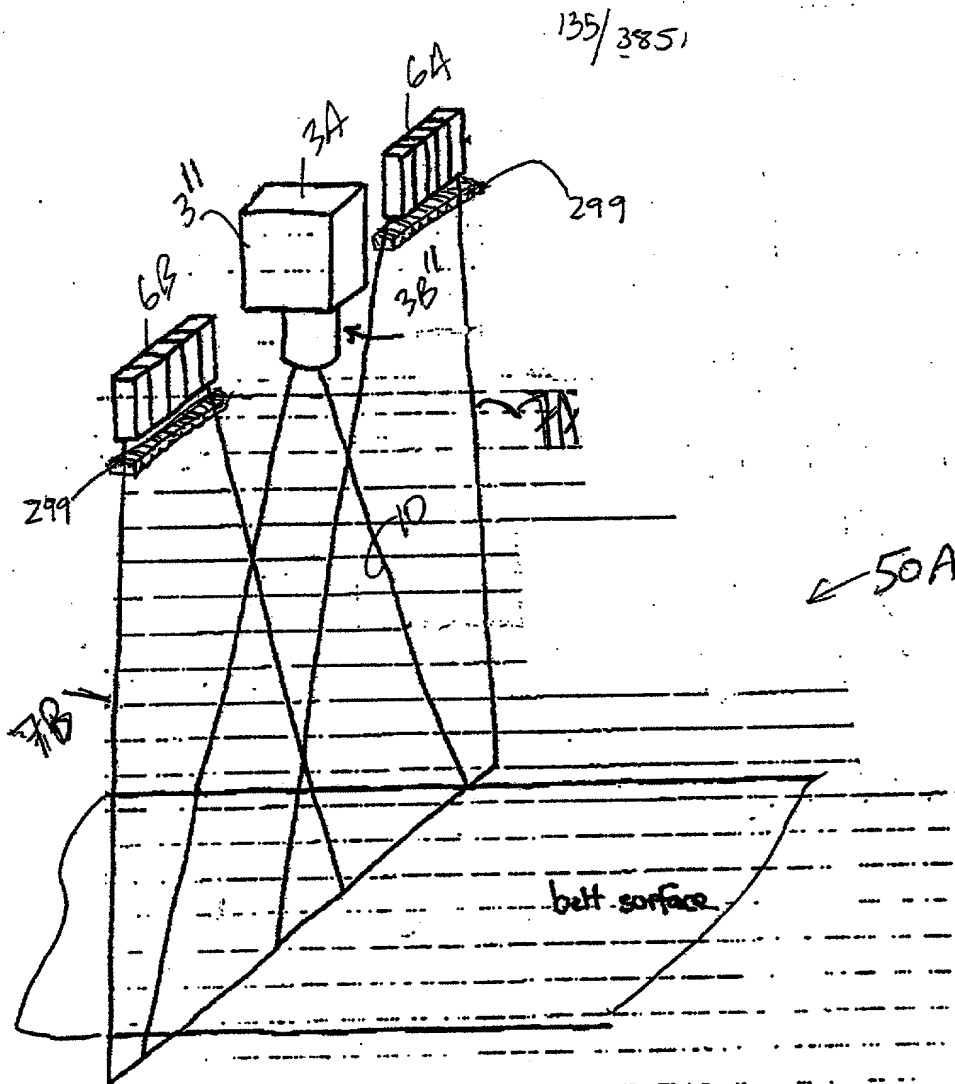


FIG. 3B1

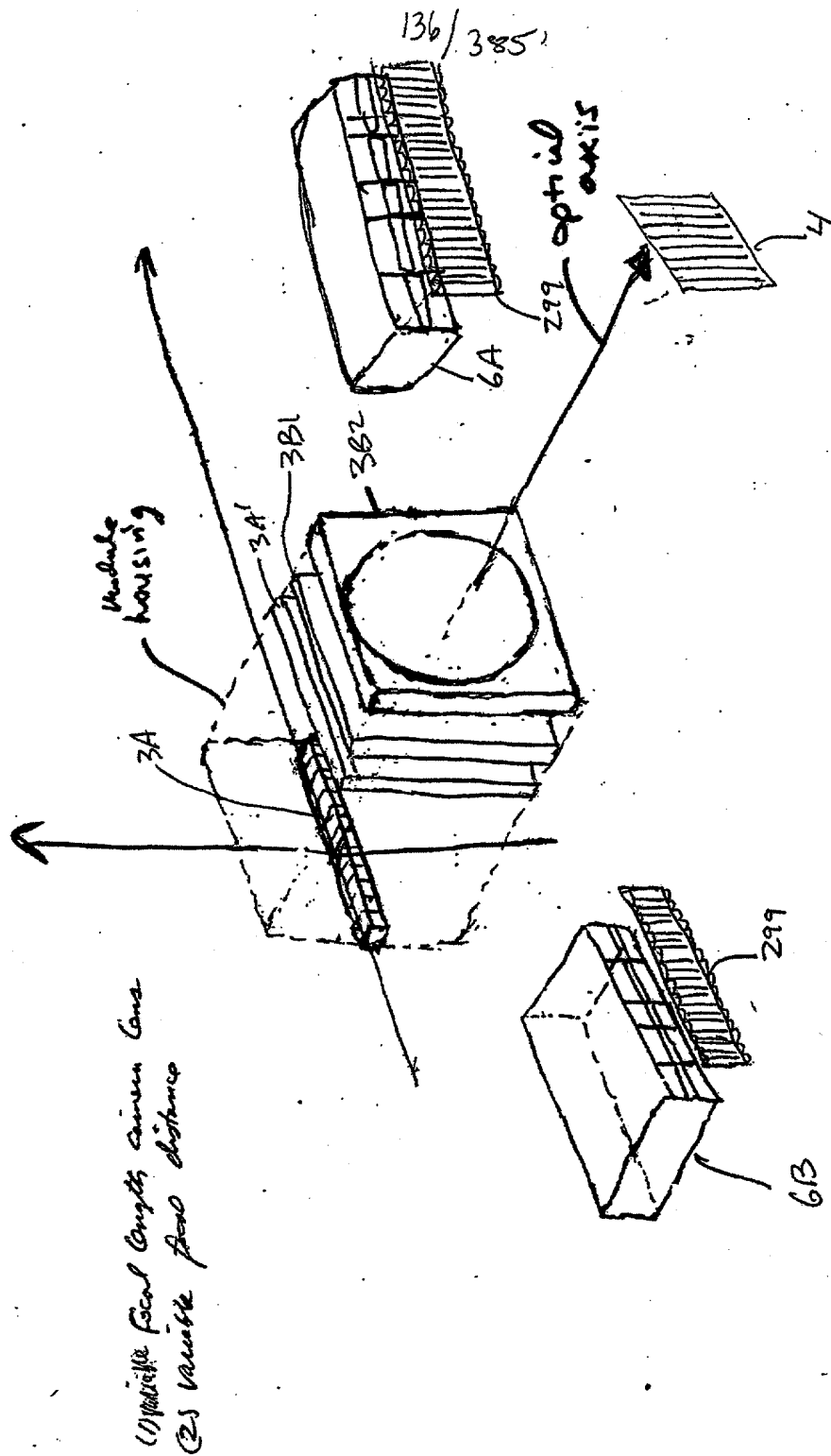
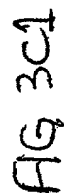


FIG. 3B2



50A

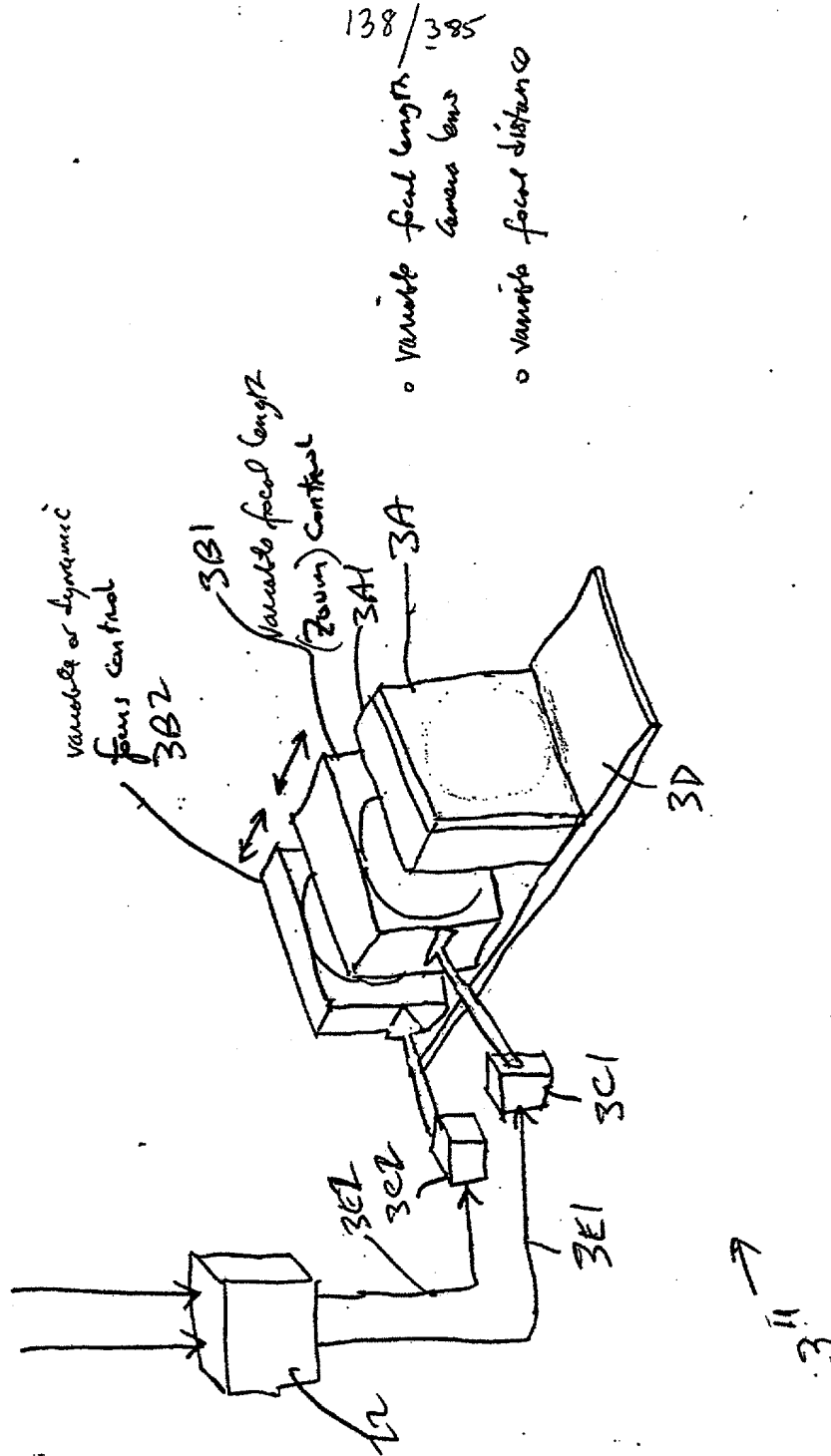
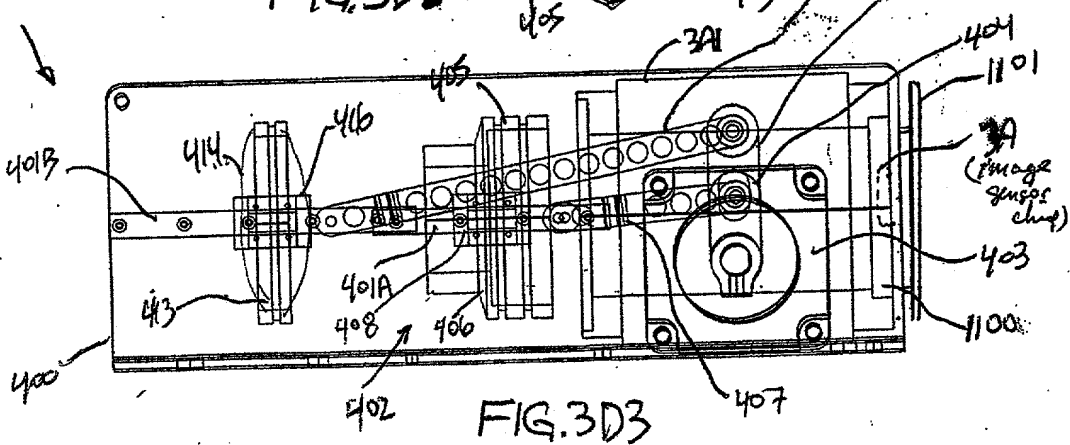
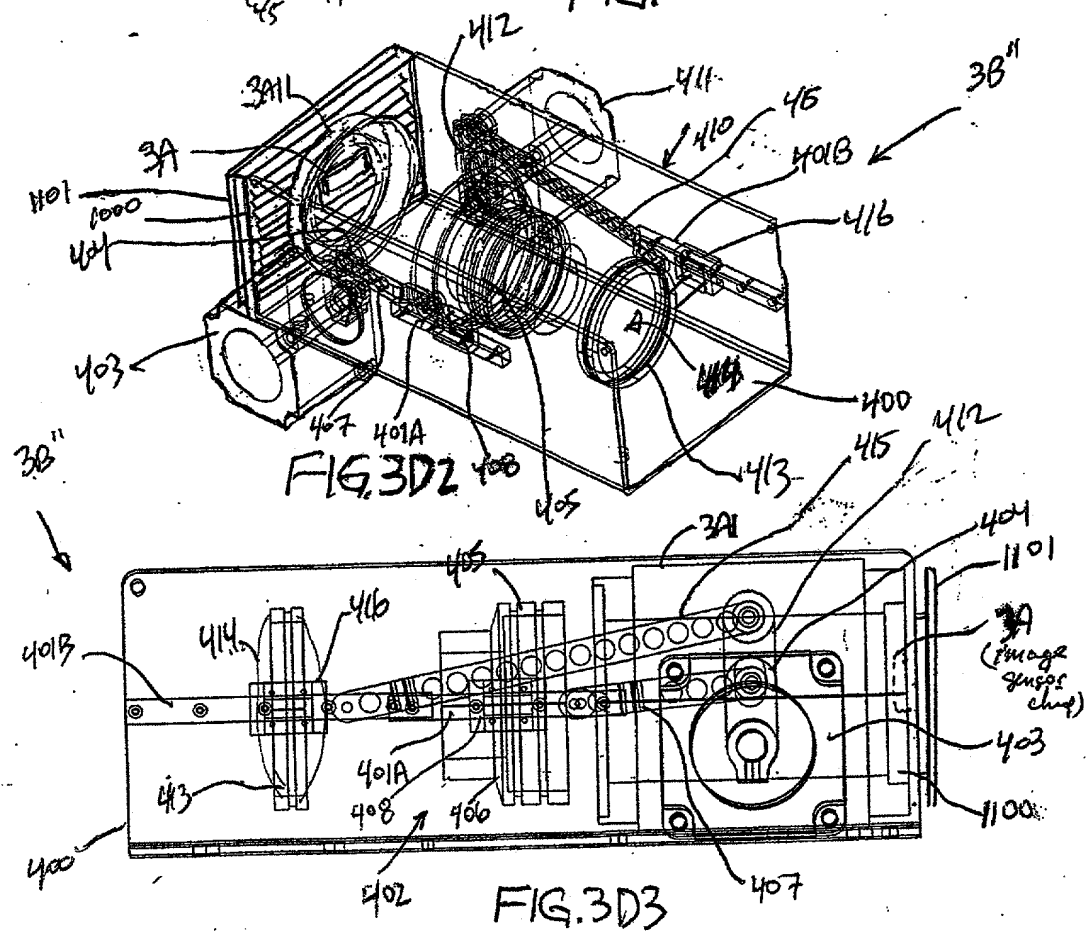
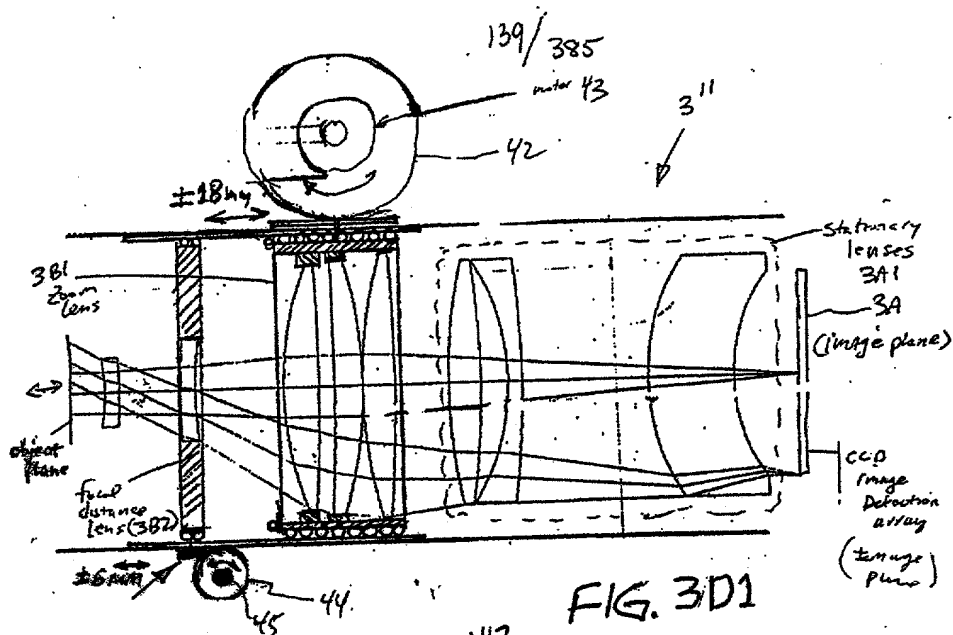


FIG. 3C2



10068462.020702

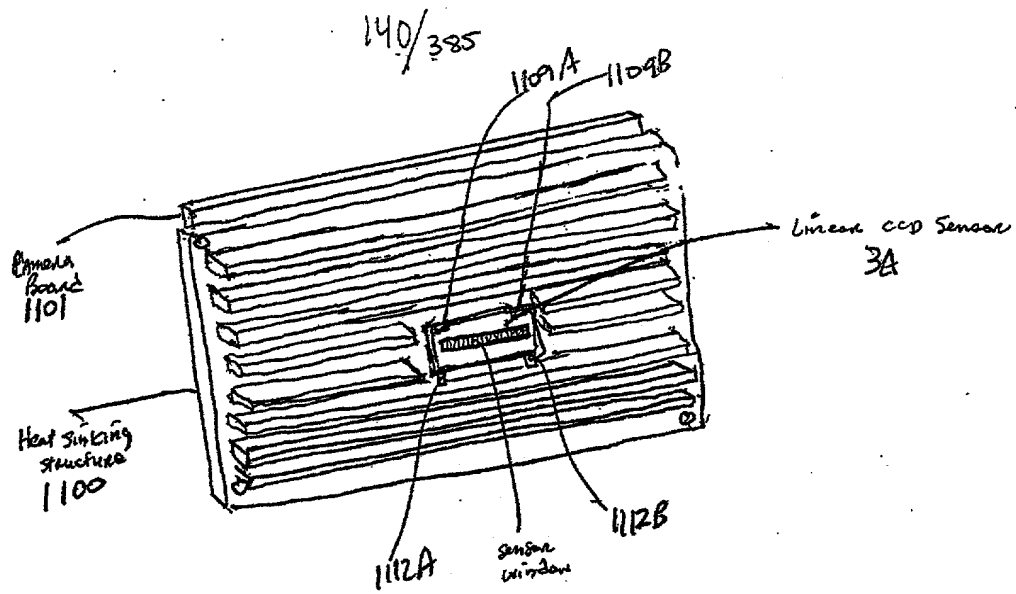


FIG. 3D4

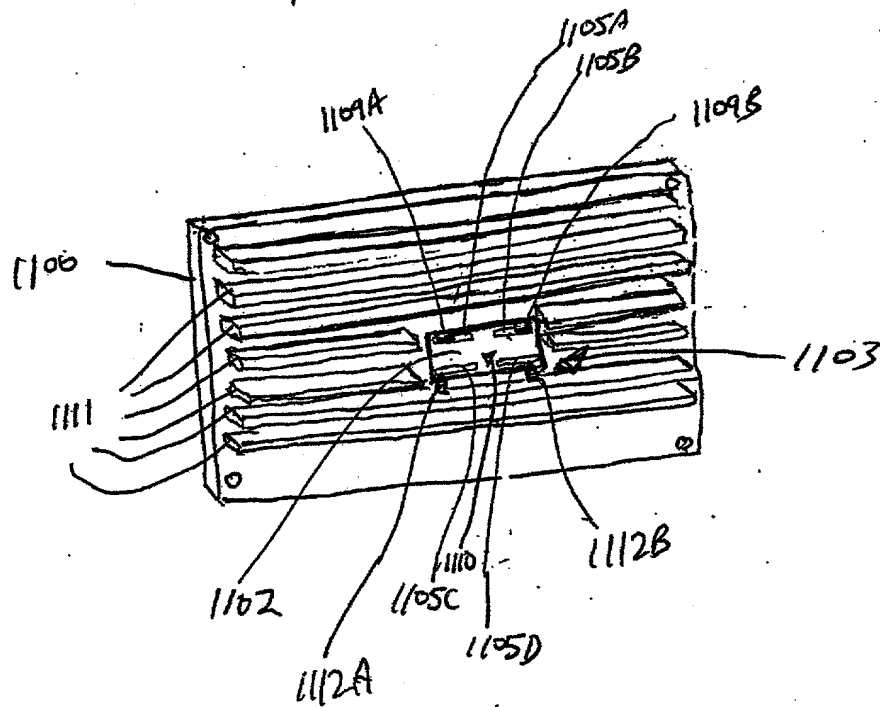


FIG. 3D5



10068462.020702

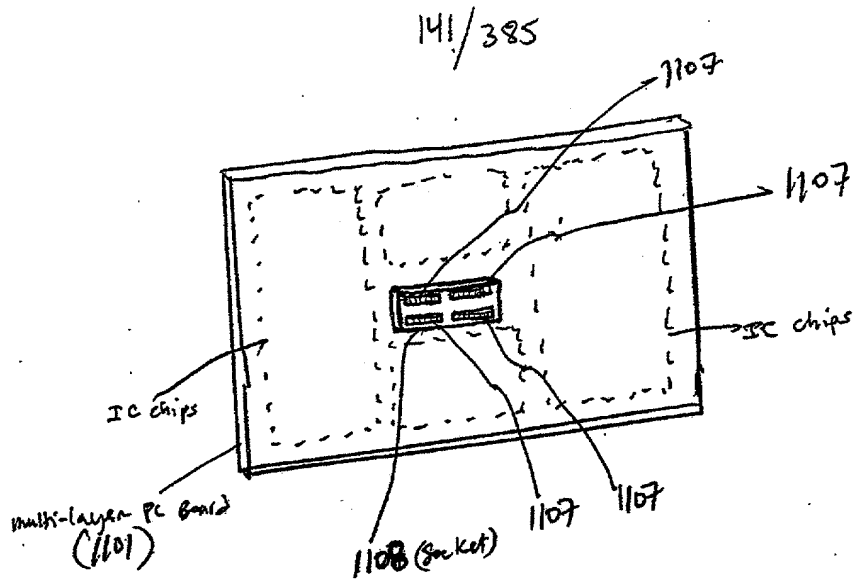


FIG. 3D6

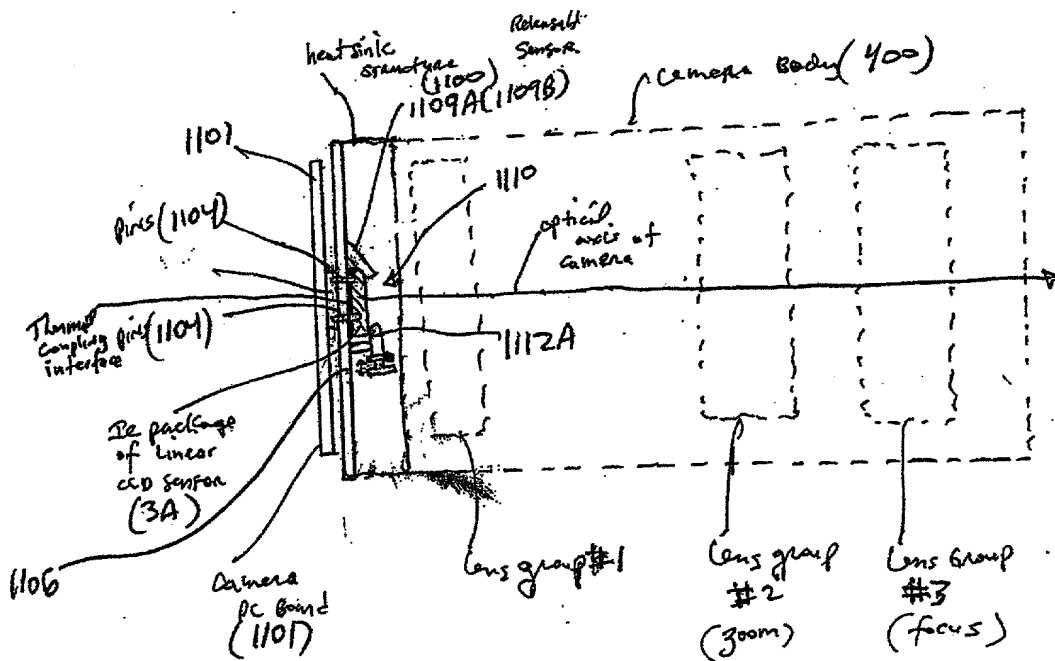


FIG. 3D7

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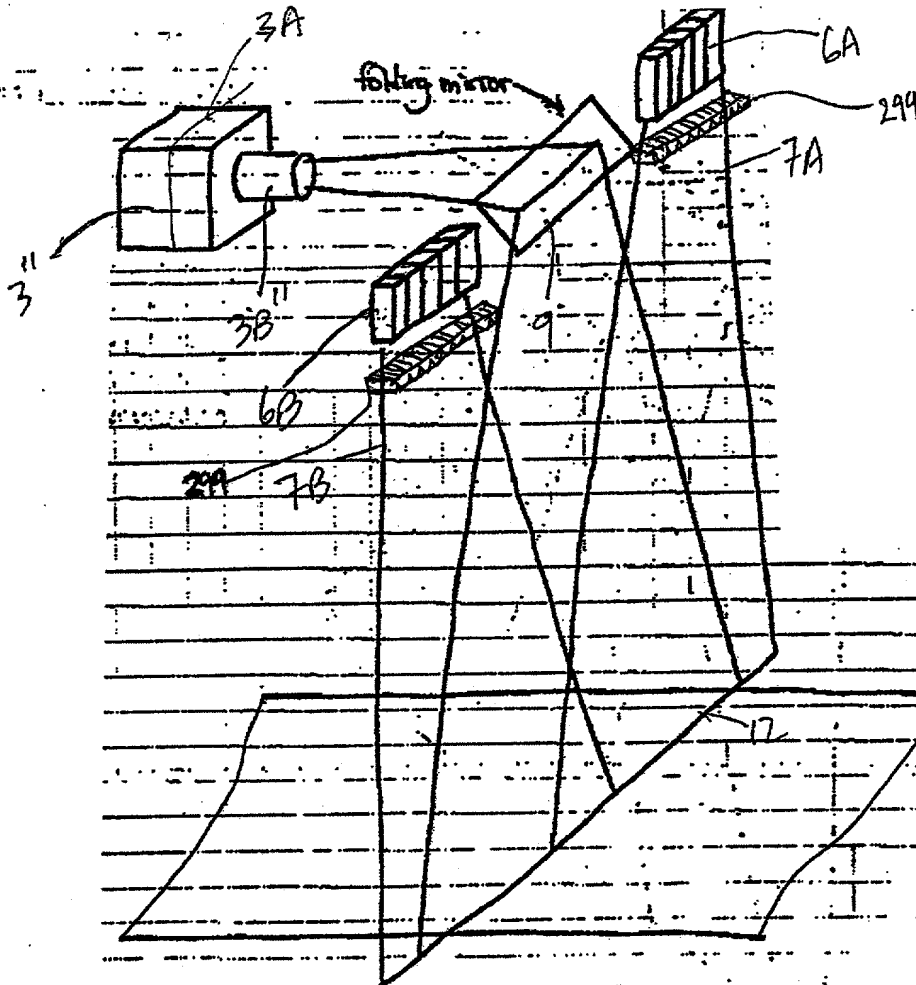


FIG. 3E1

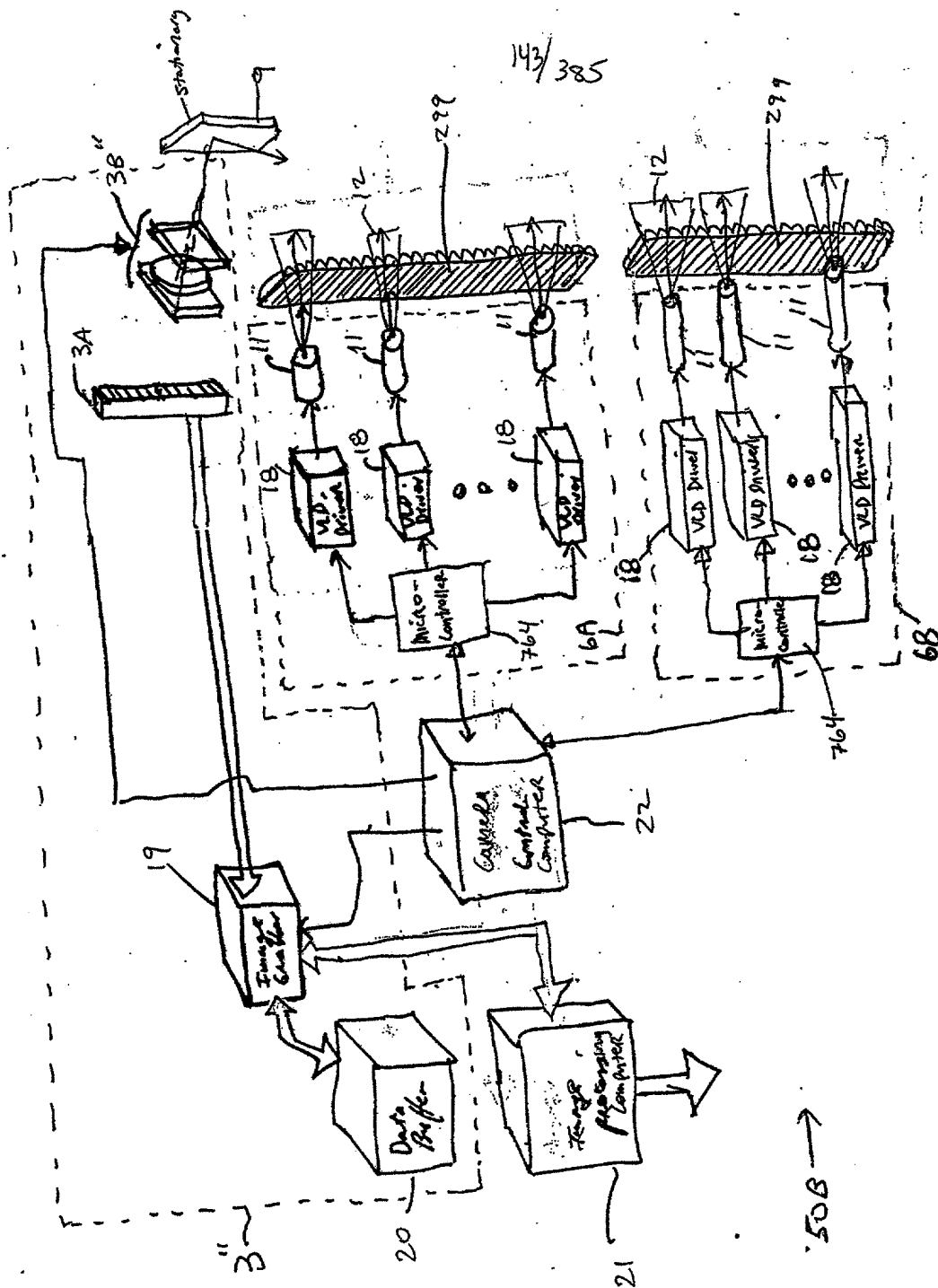


FIG. 3E2

10068462, 020702

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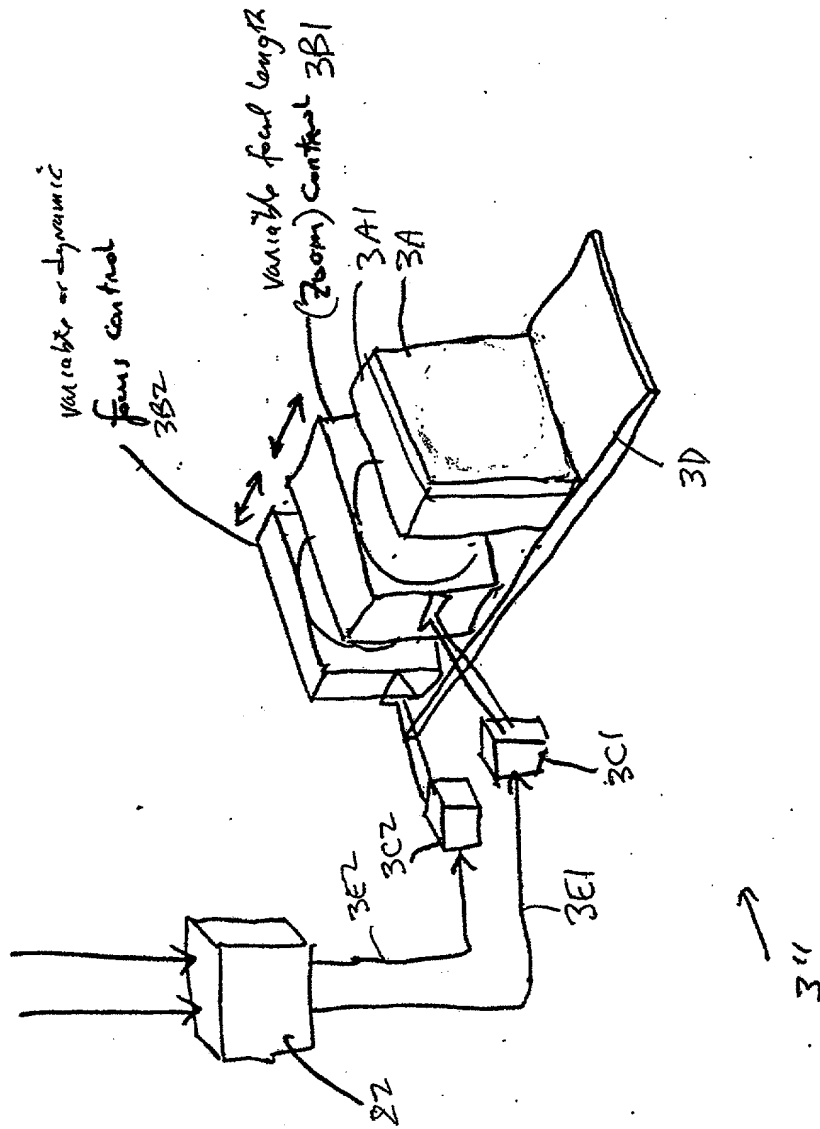


FIG. 3E3

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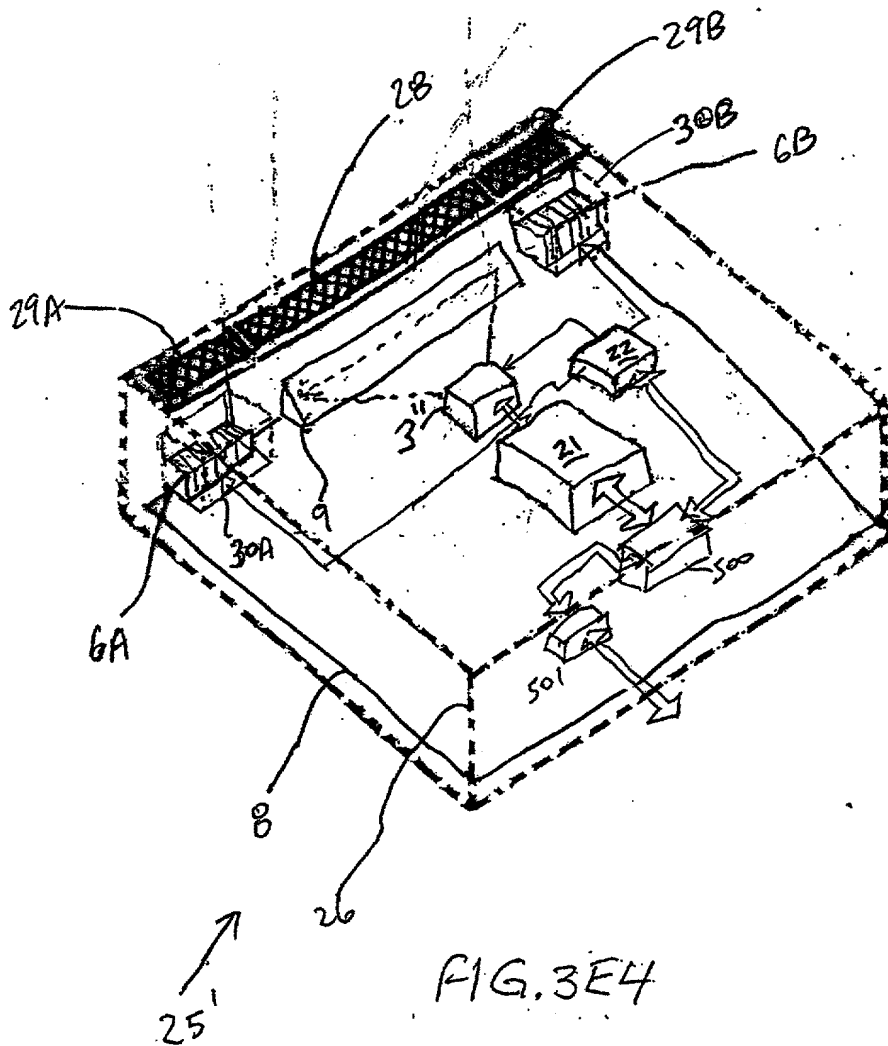


FIG. 3E4



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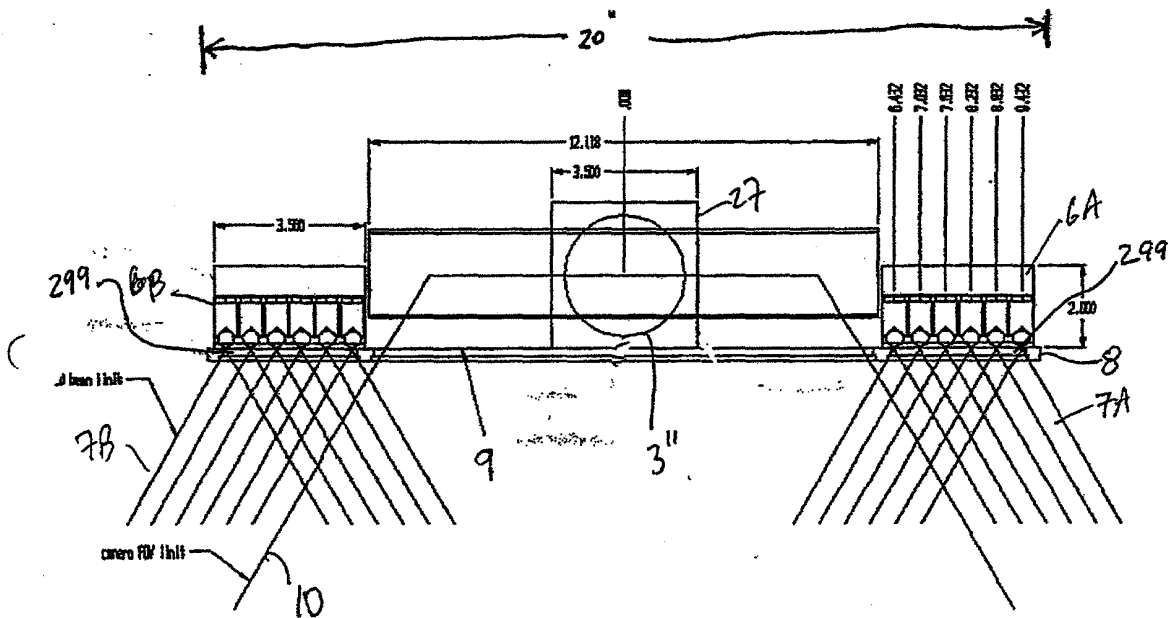


FIG. 3E6

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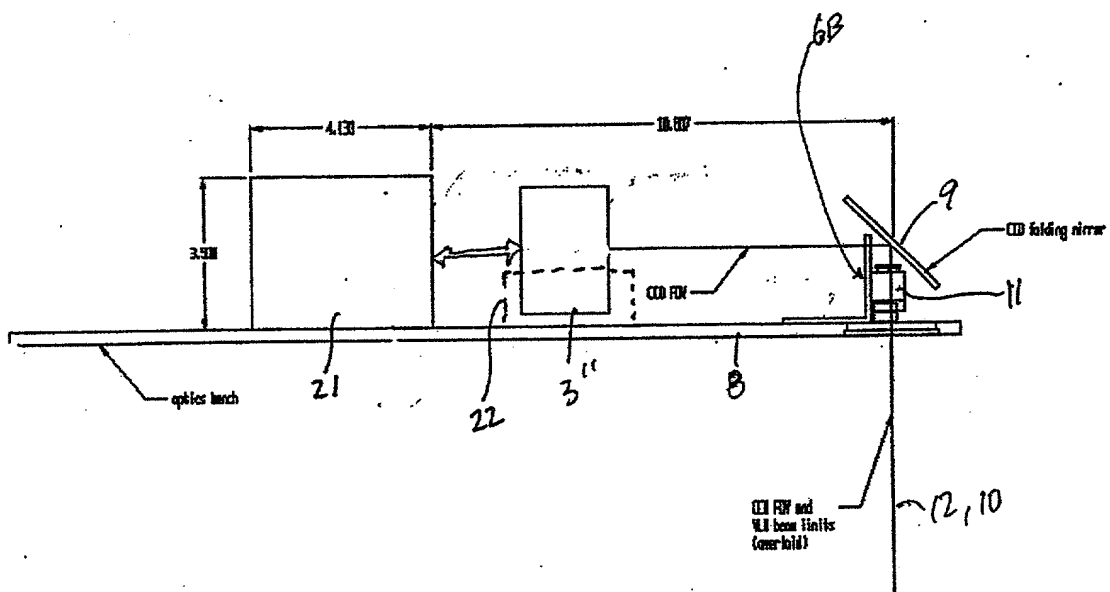


FIG. 3E7



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\*Variable FOV

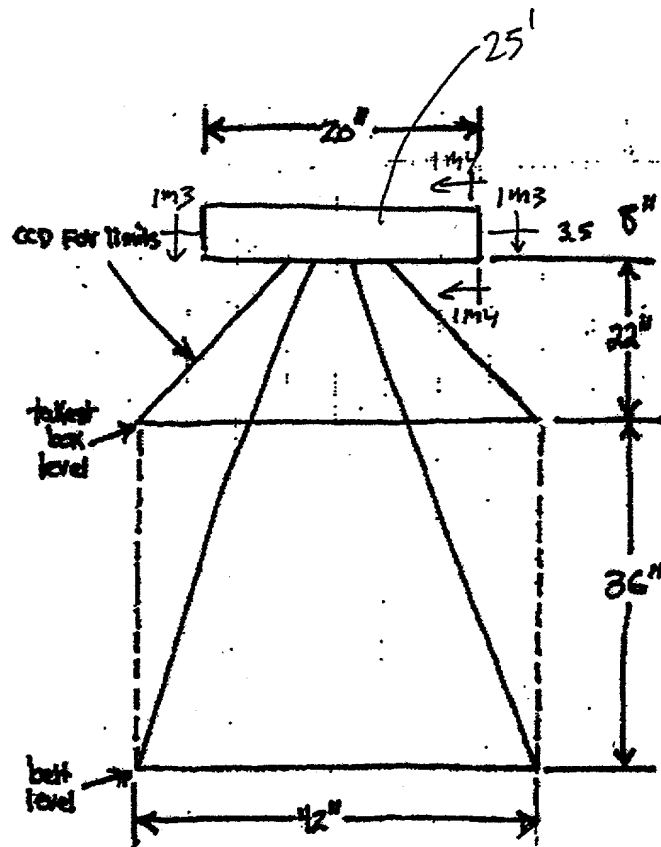


FIG. 3E8

10068452.020702

**TOTAL OF \$900**

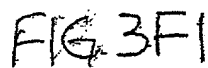
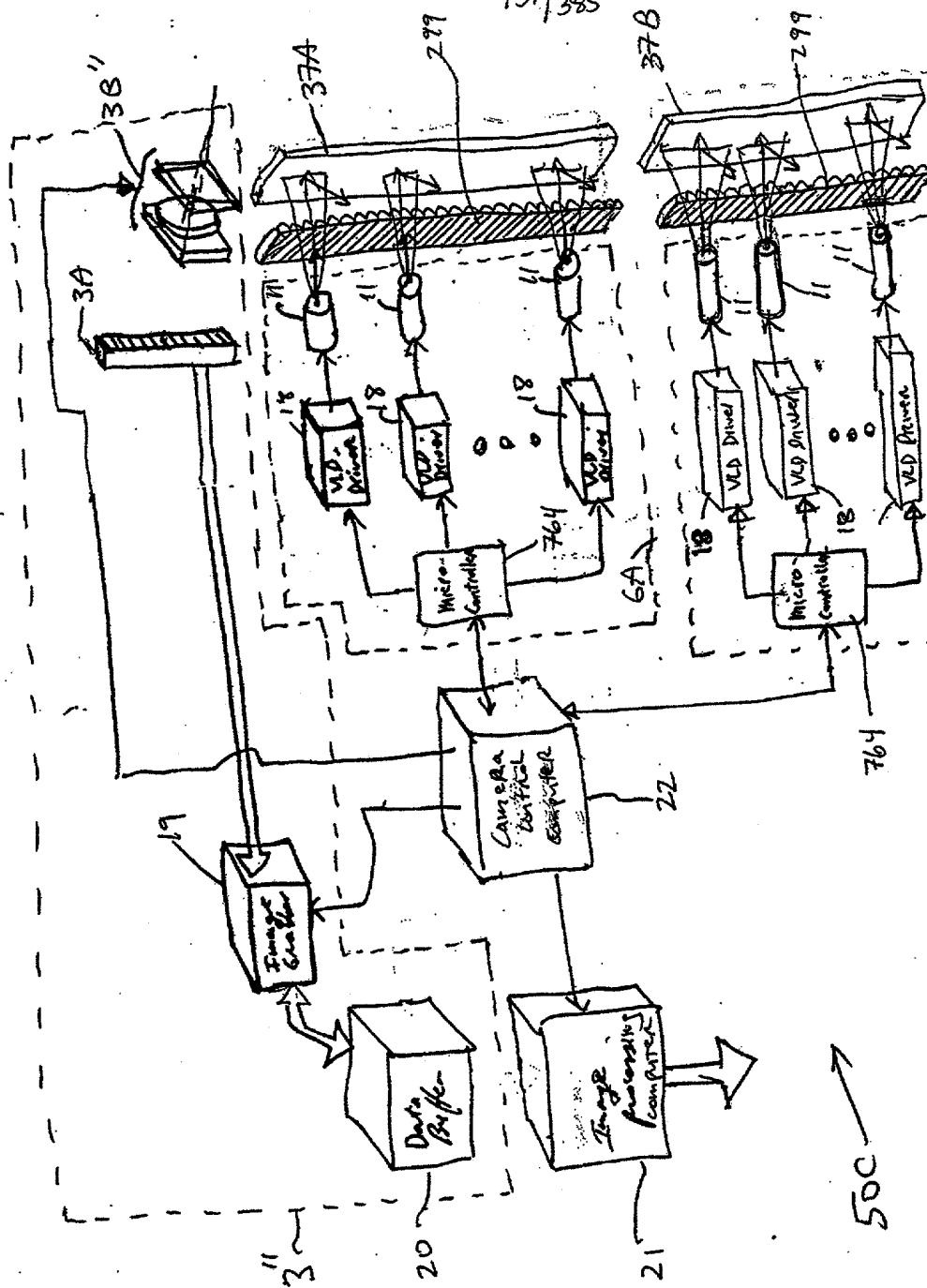


FIG. 3F1



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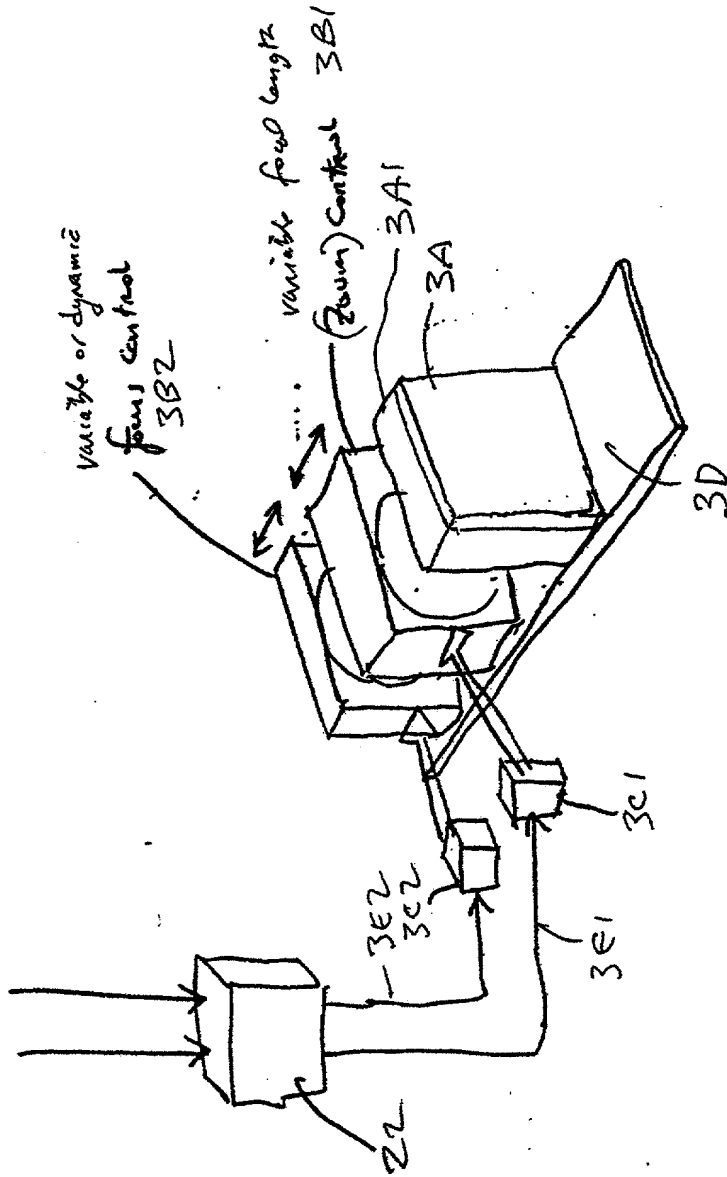


FIG. 3F3

10058462.020702

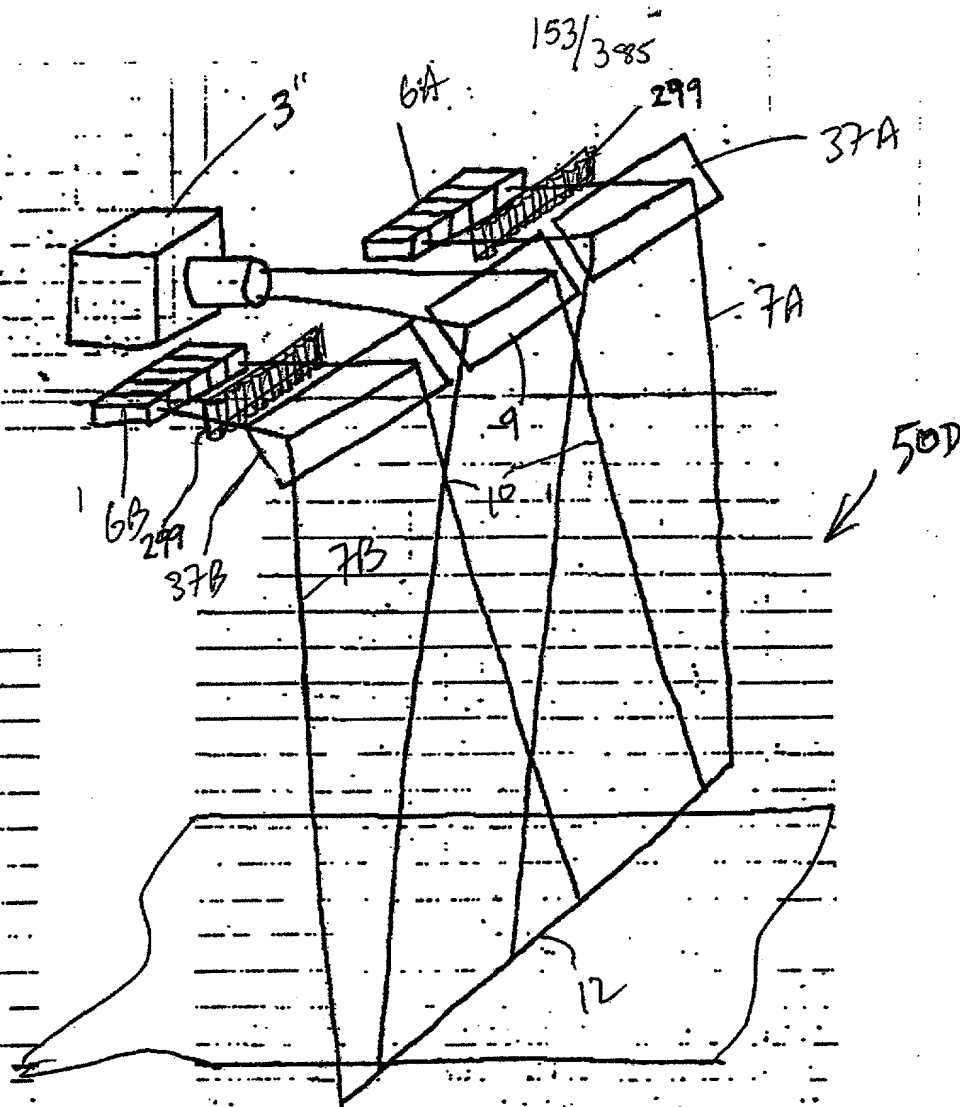


FIG. 351

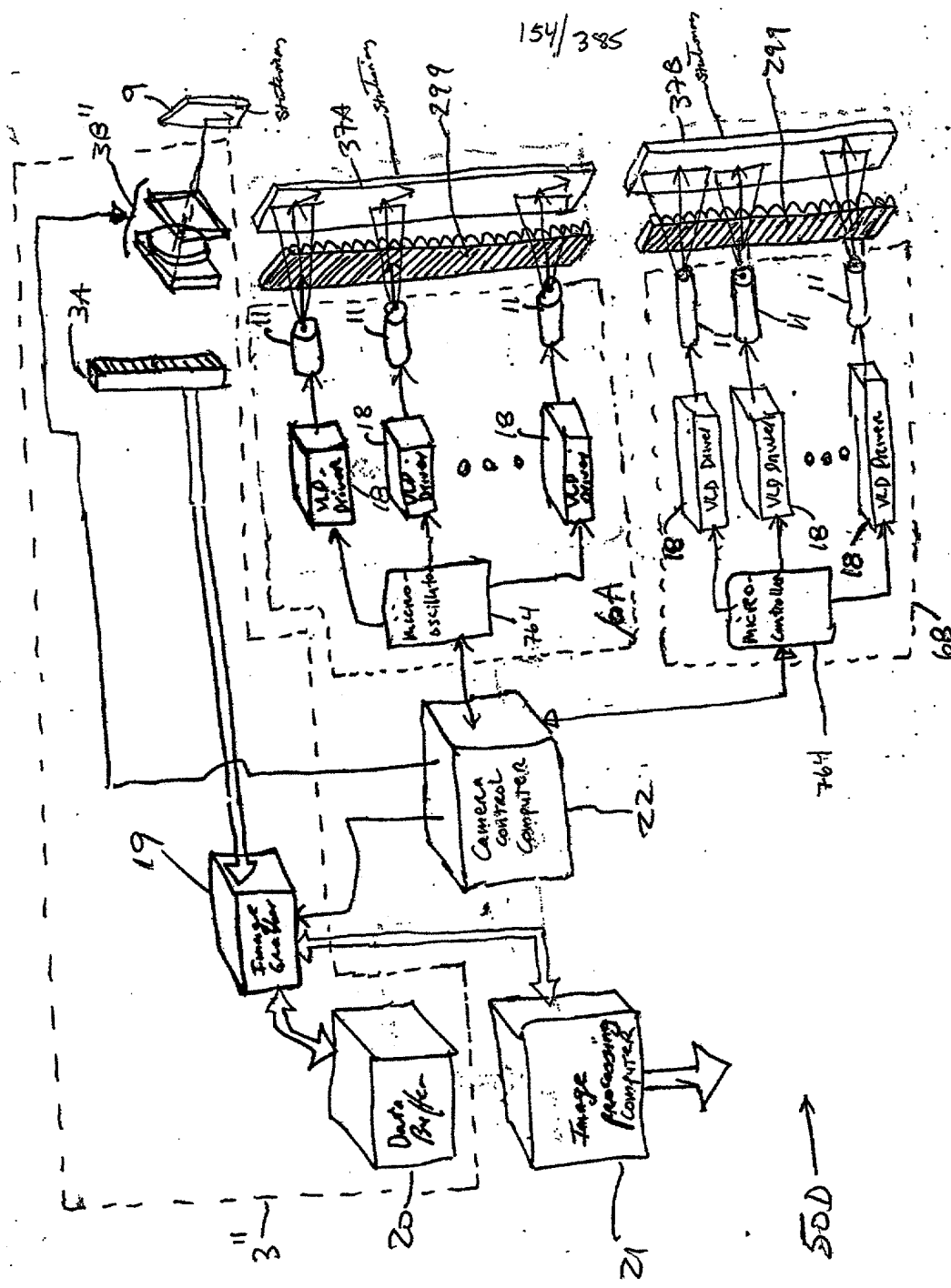


FIG. 392

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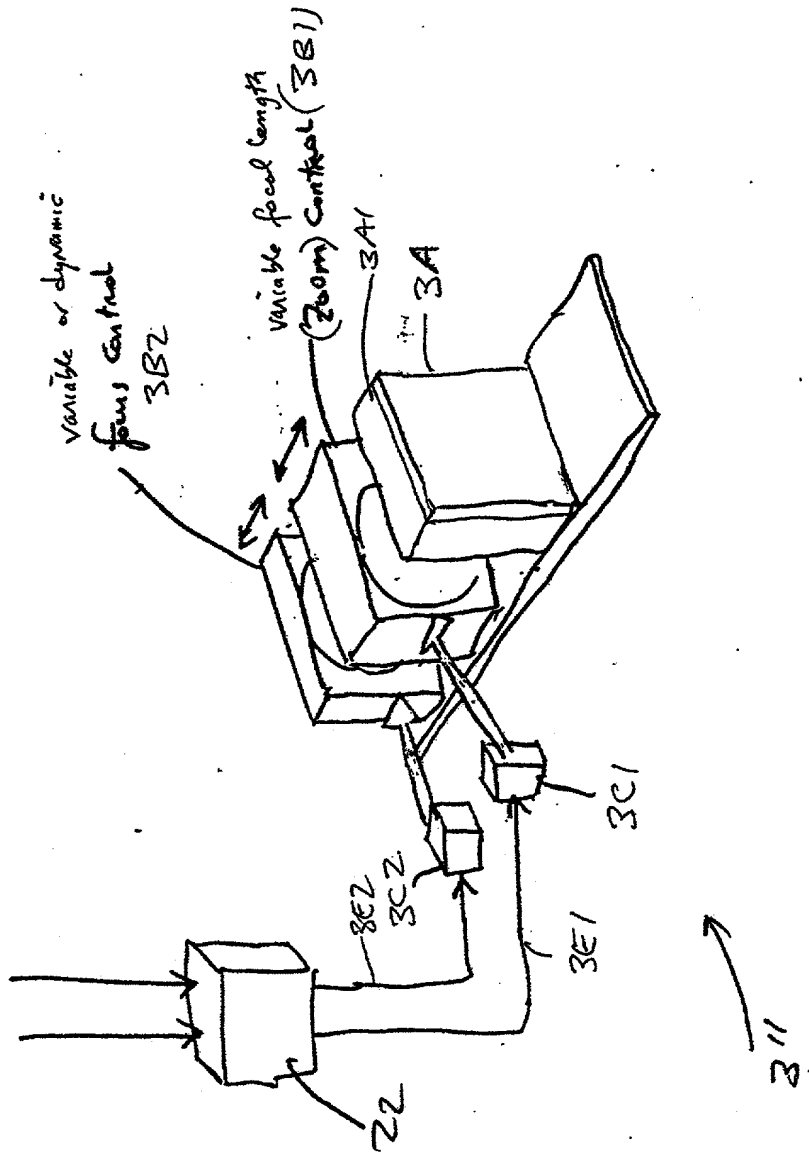


FIG. 393

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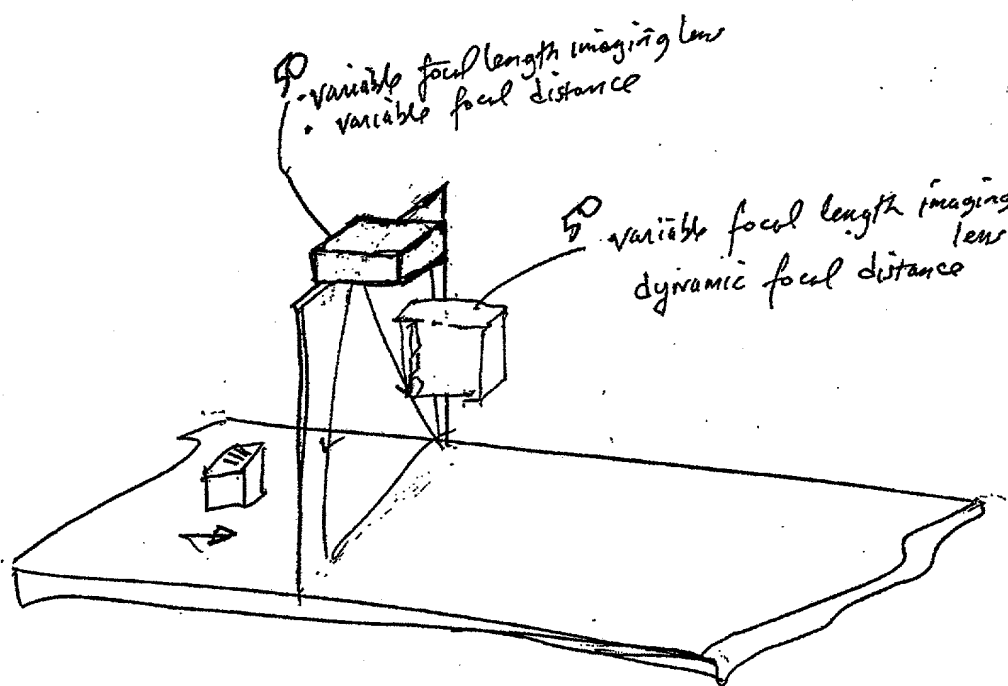


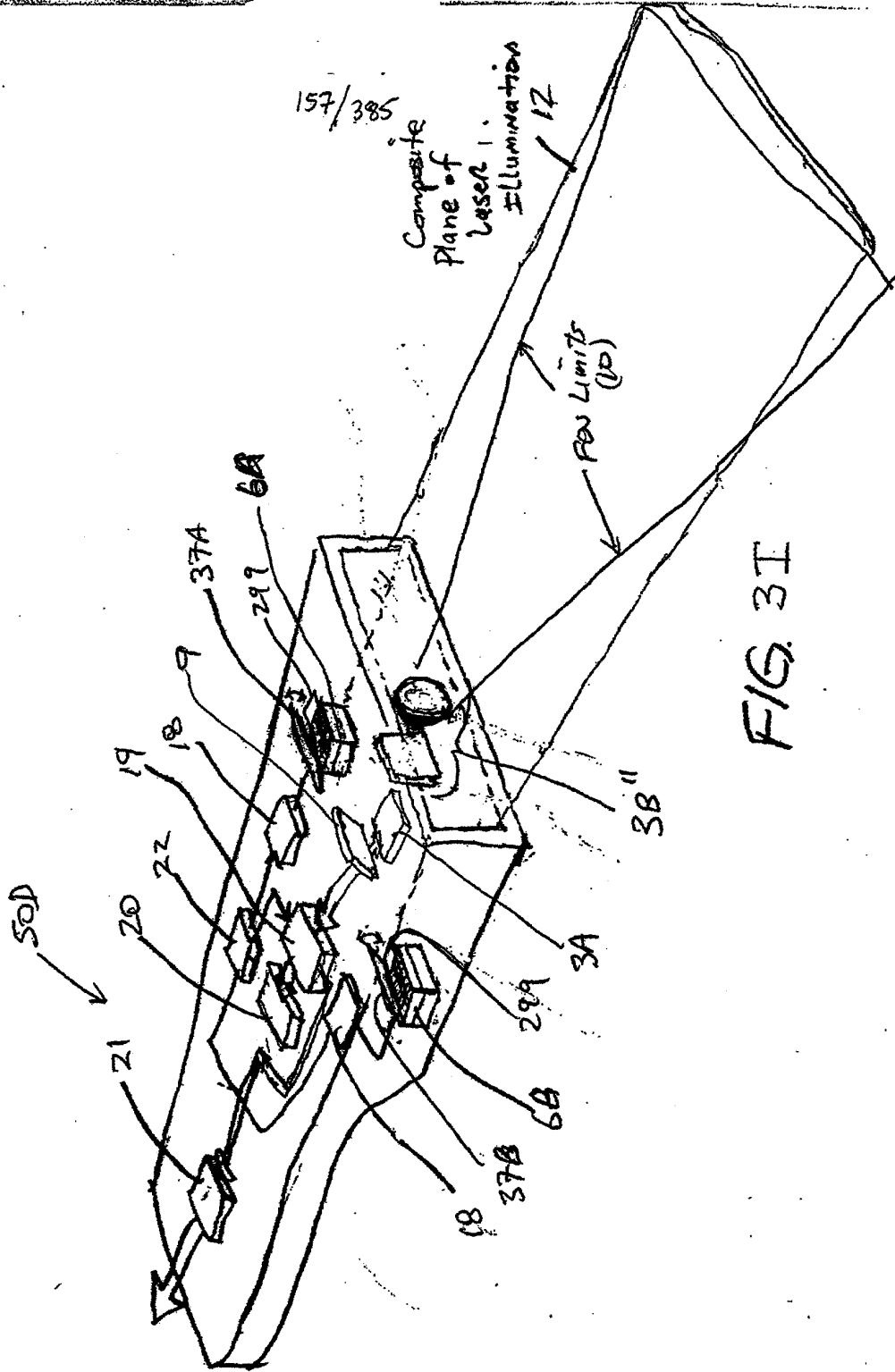
FIG. 3H

10058462.000702



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C



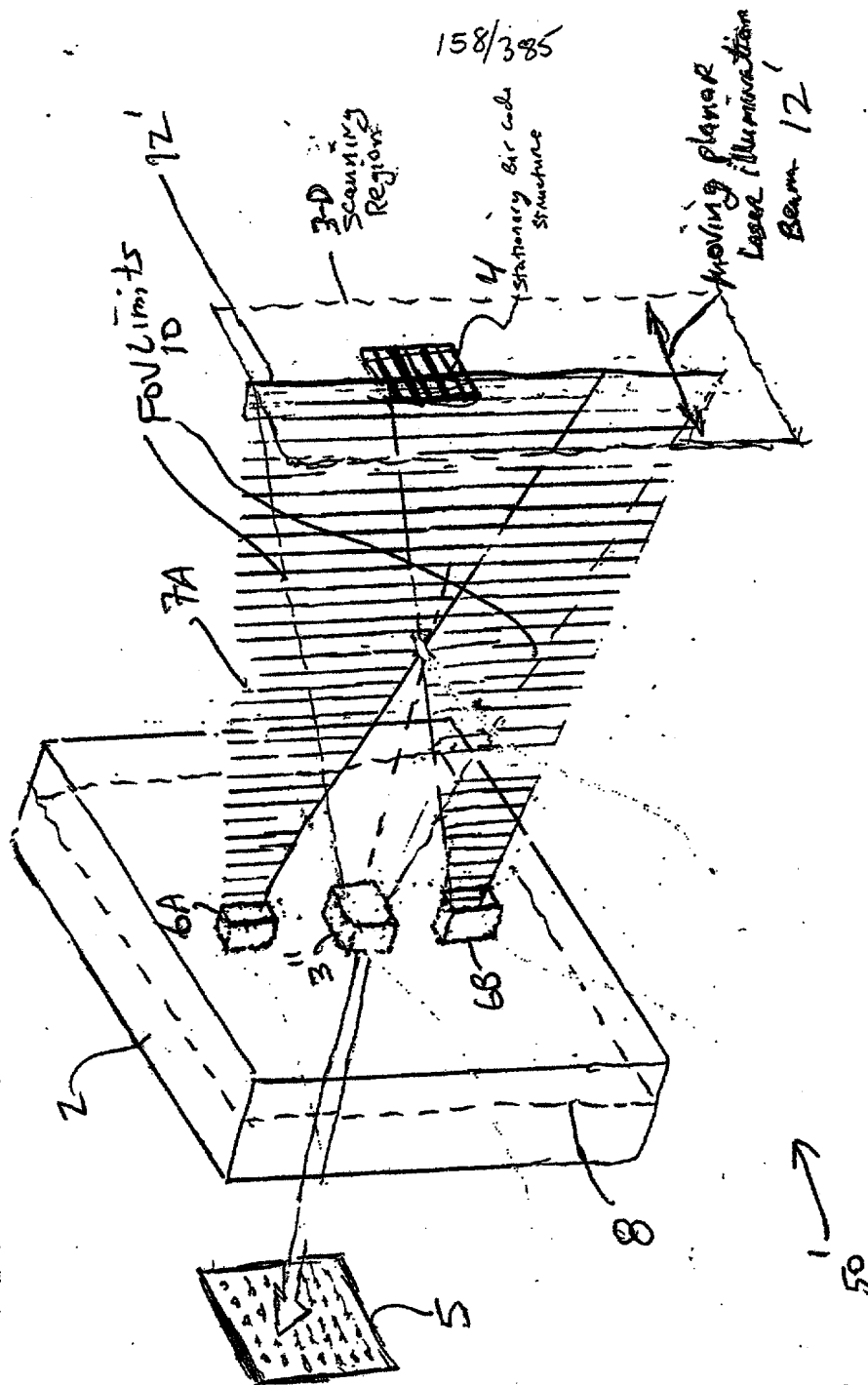


FIG. 3J1

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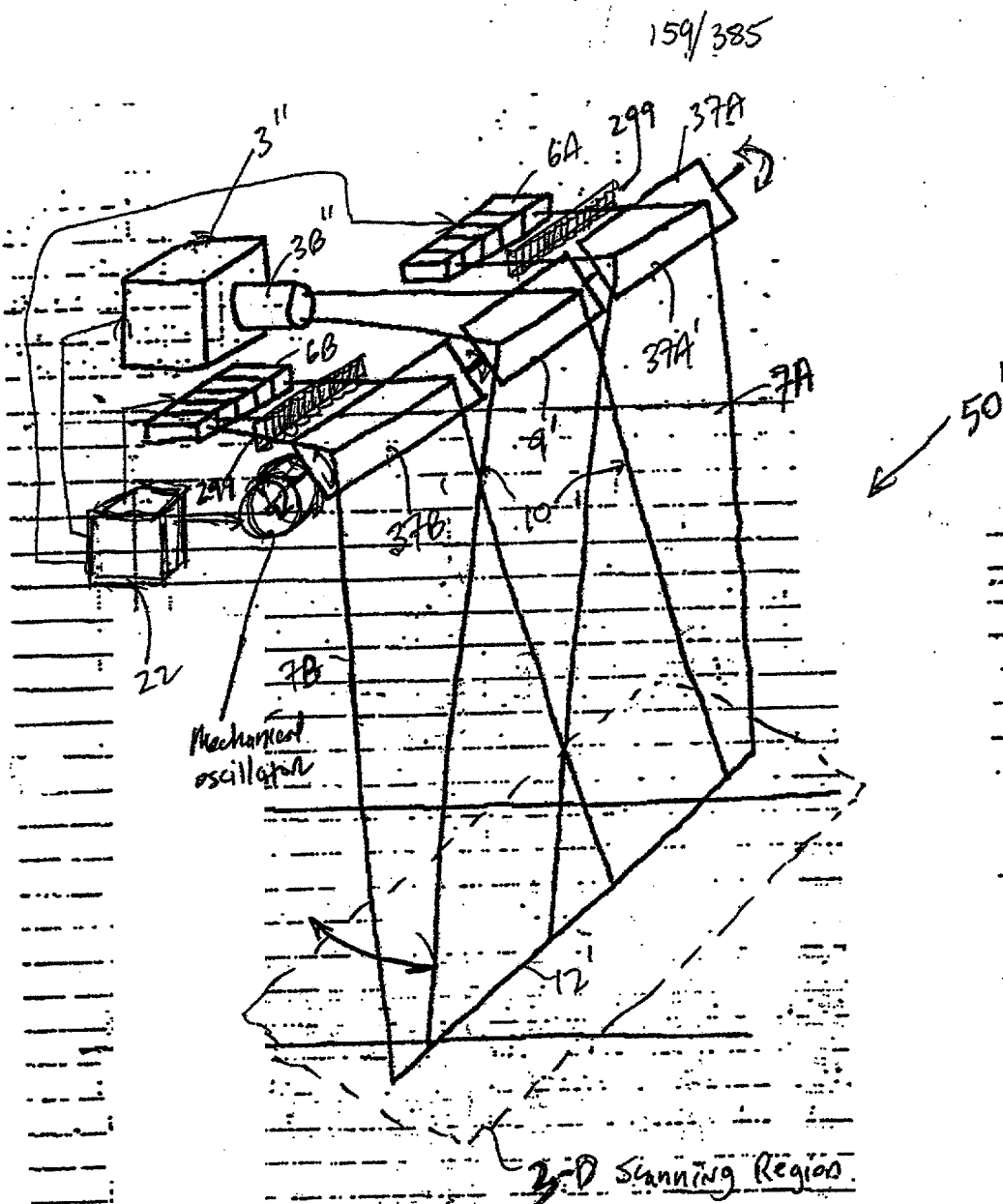


FIG 3J2



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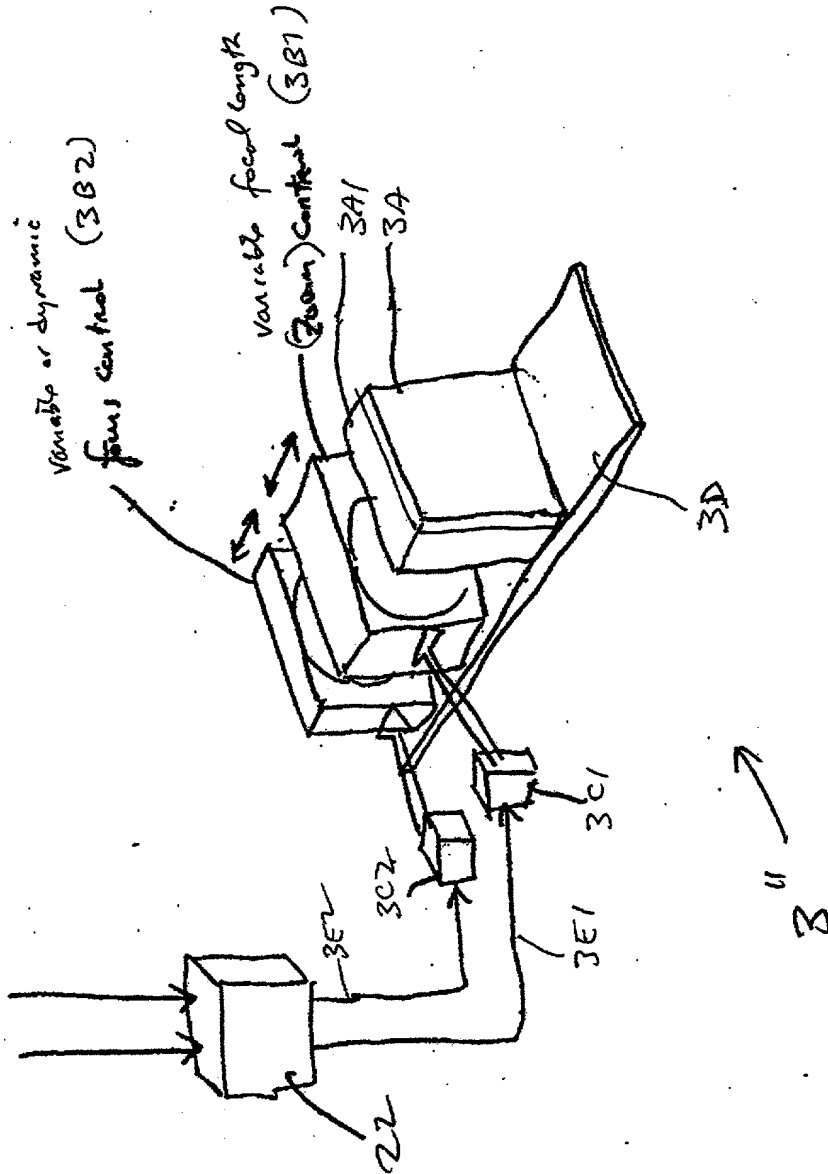


FIG. 3J4

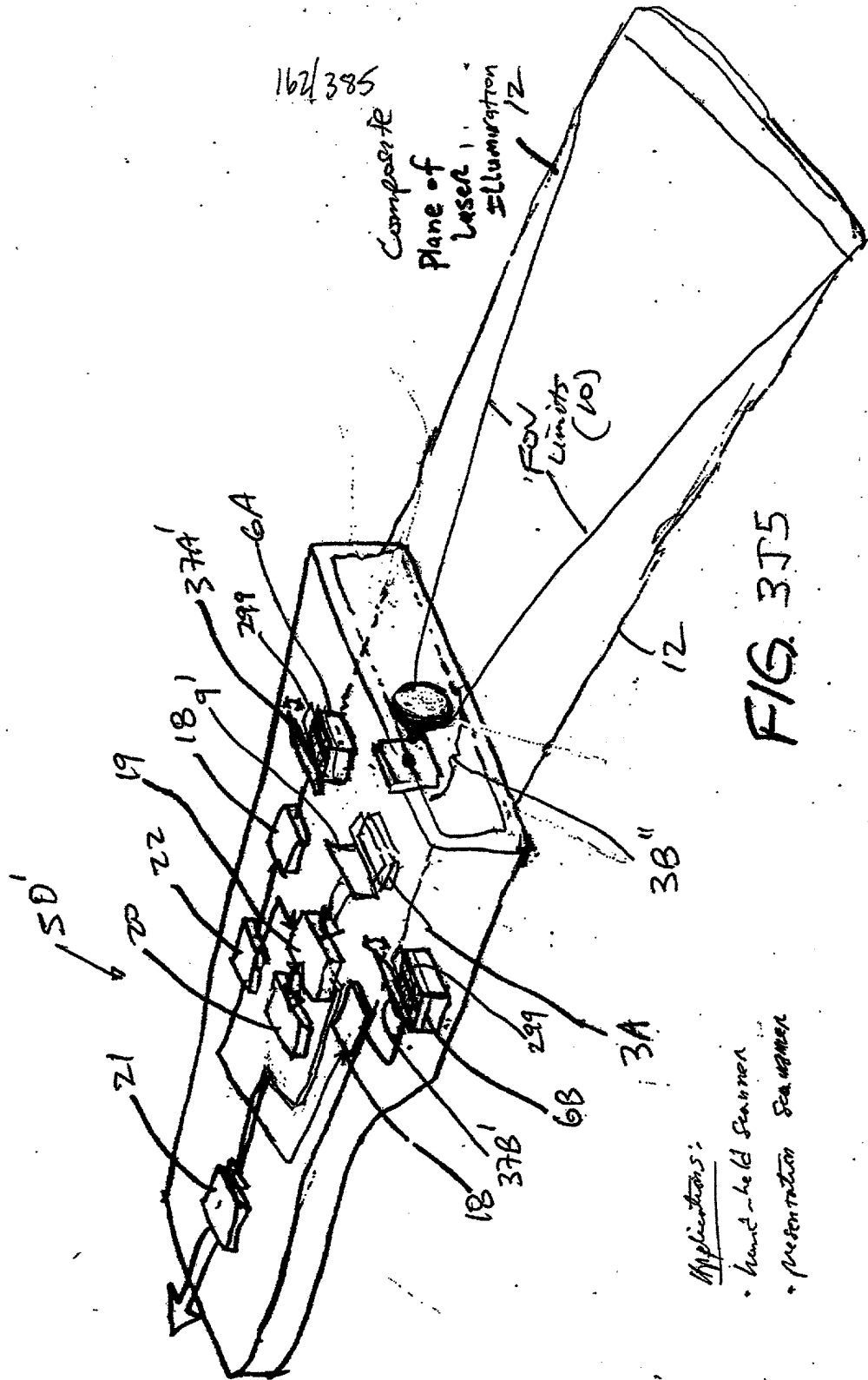


FIG. 3J5

Applications:

- Hand-held sensor
- Presentation sensor

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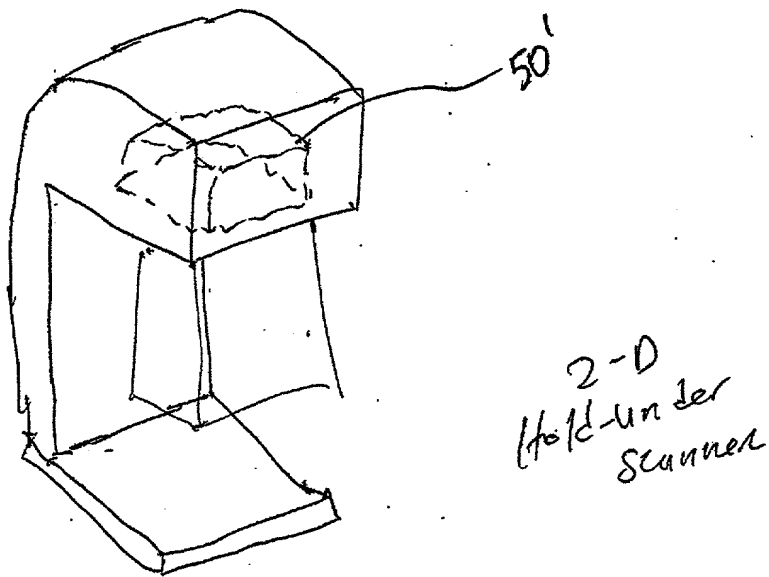


FIG-316

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CC

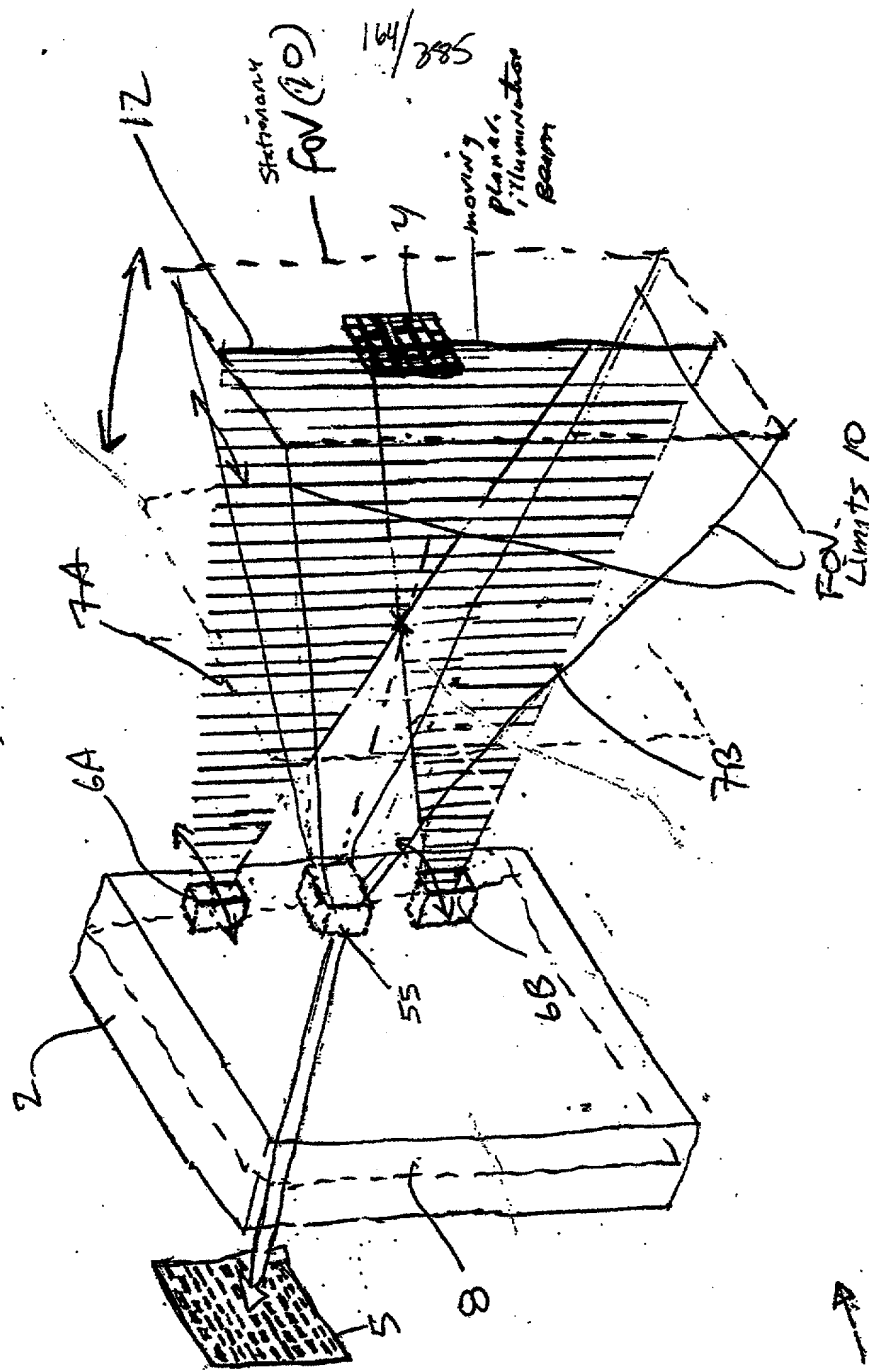


FIG 4A



1006452-020702

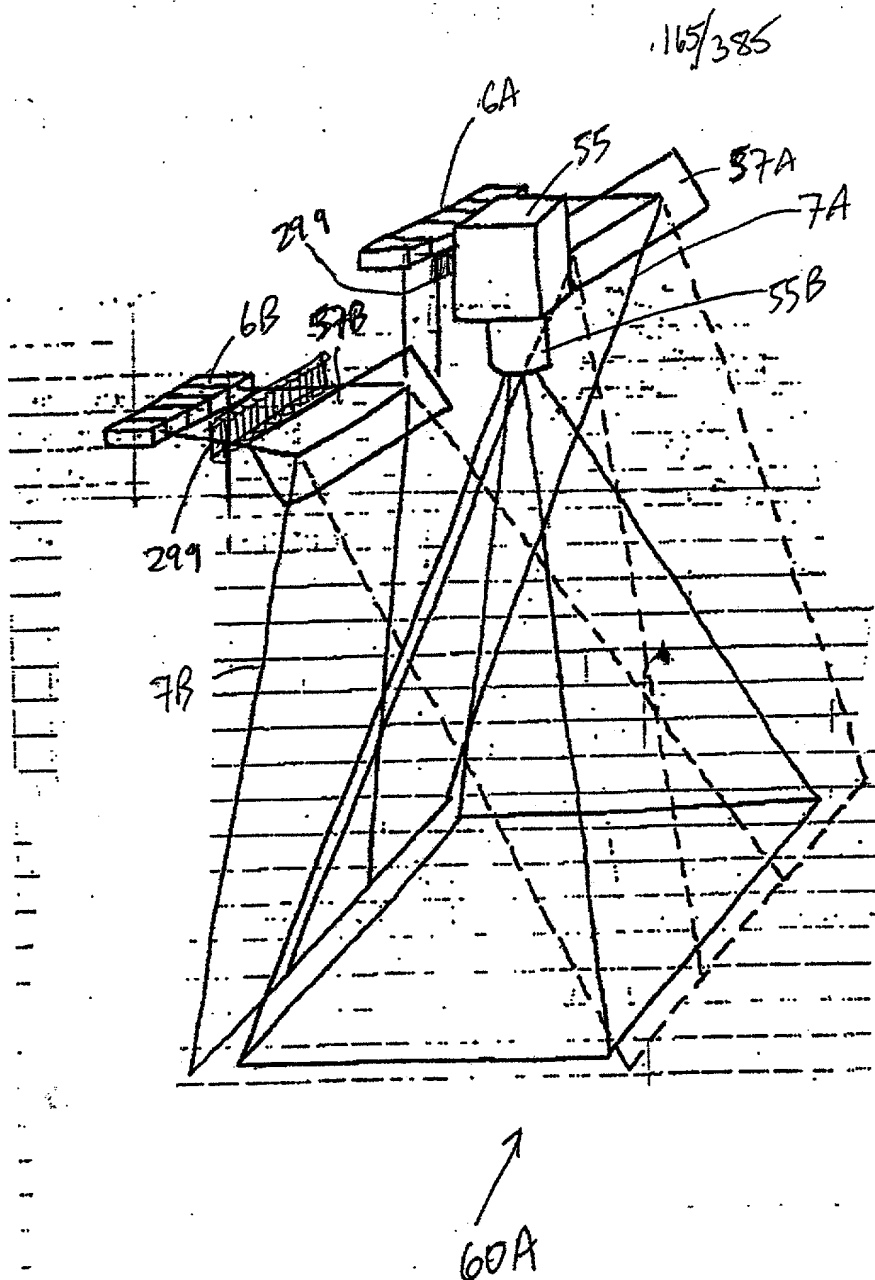


FIG. 4B1

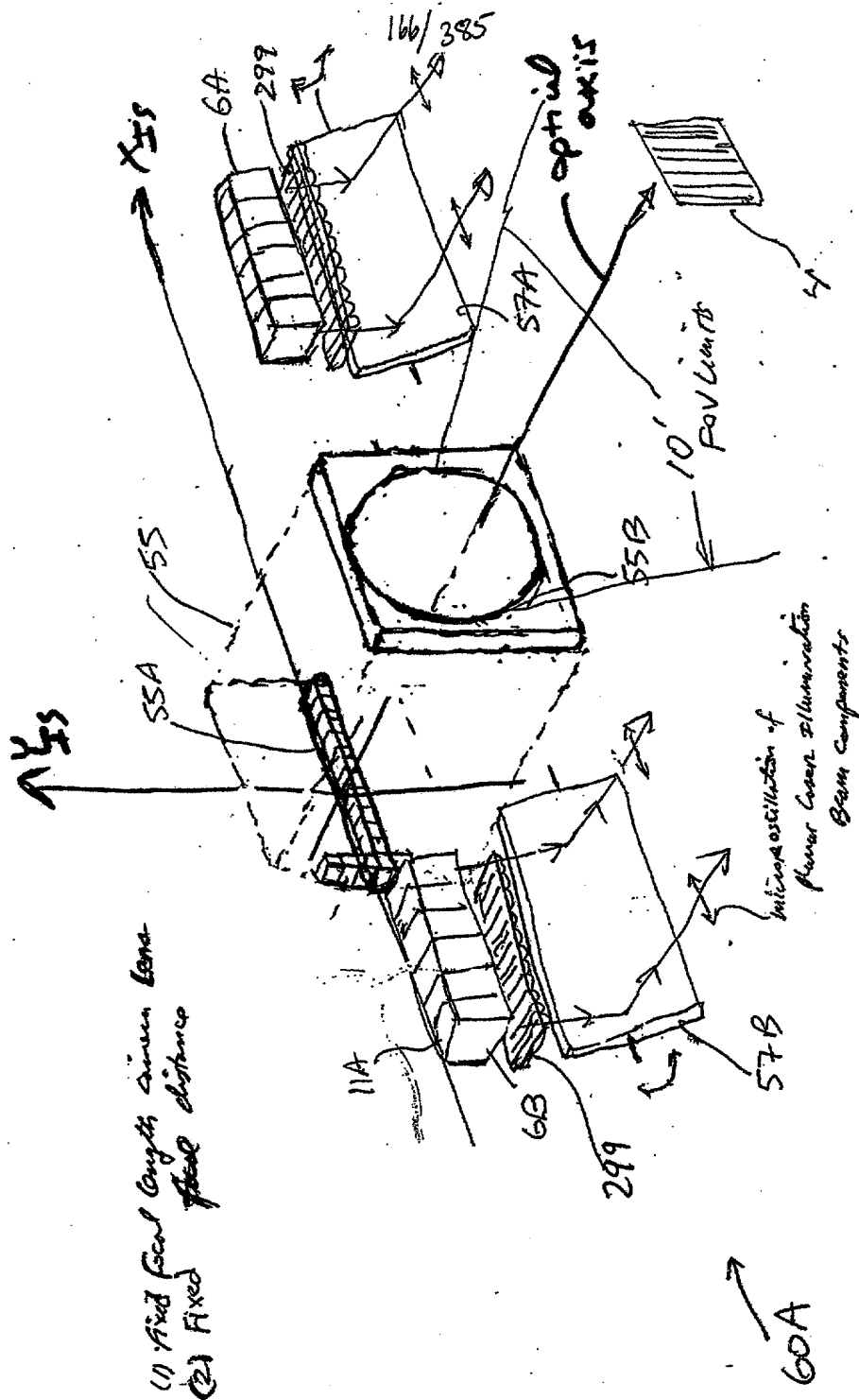


FIG. 4BZ

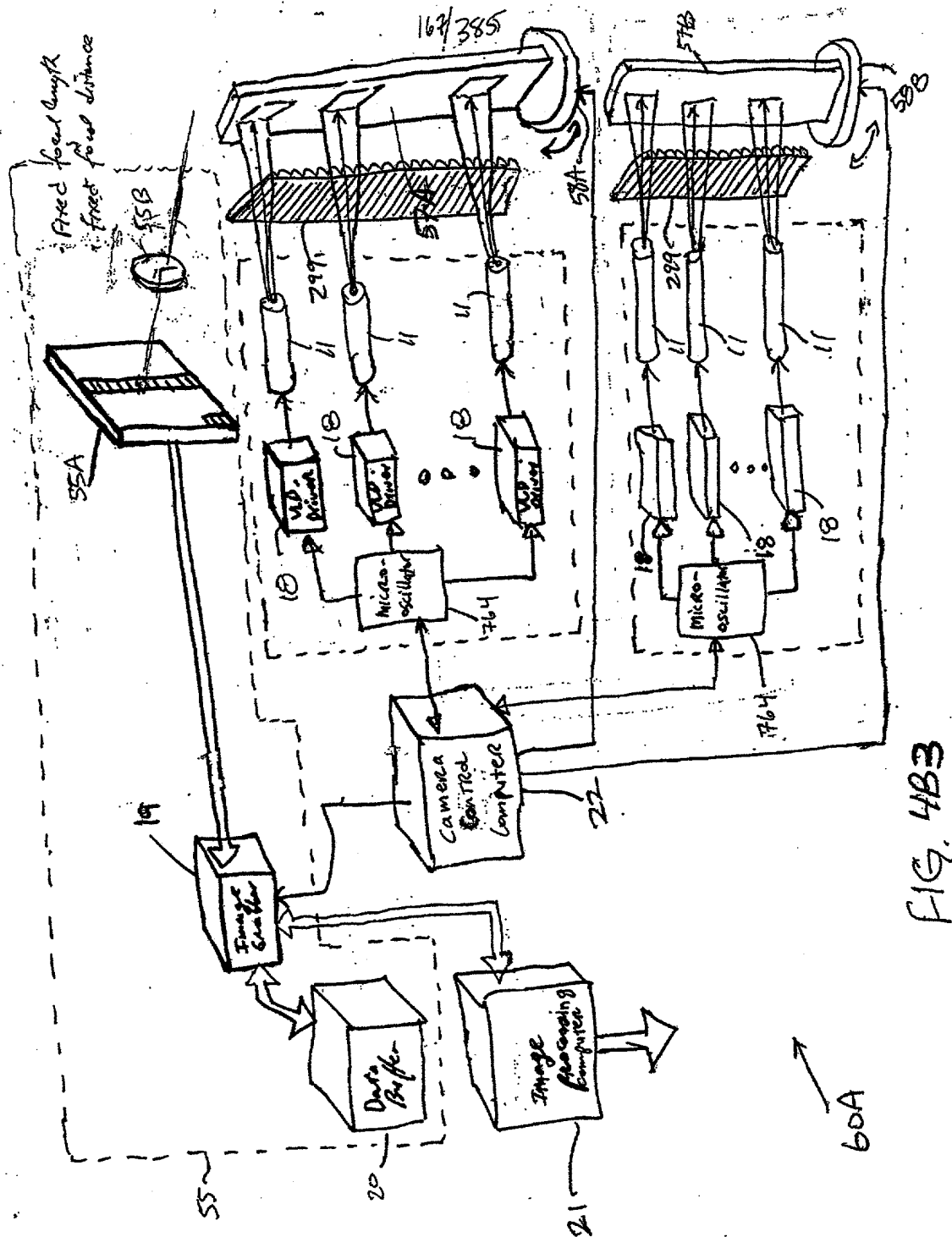


FIG. 4B3

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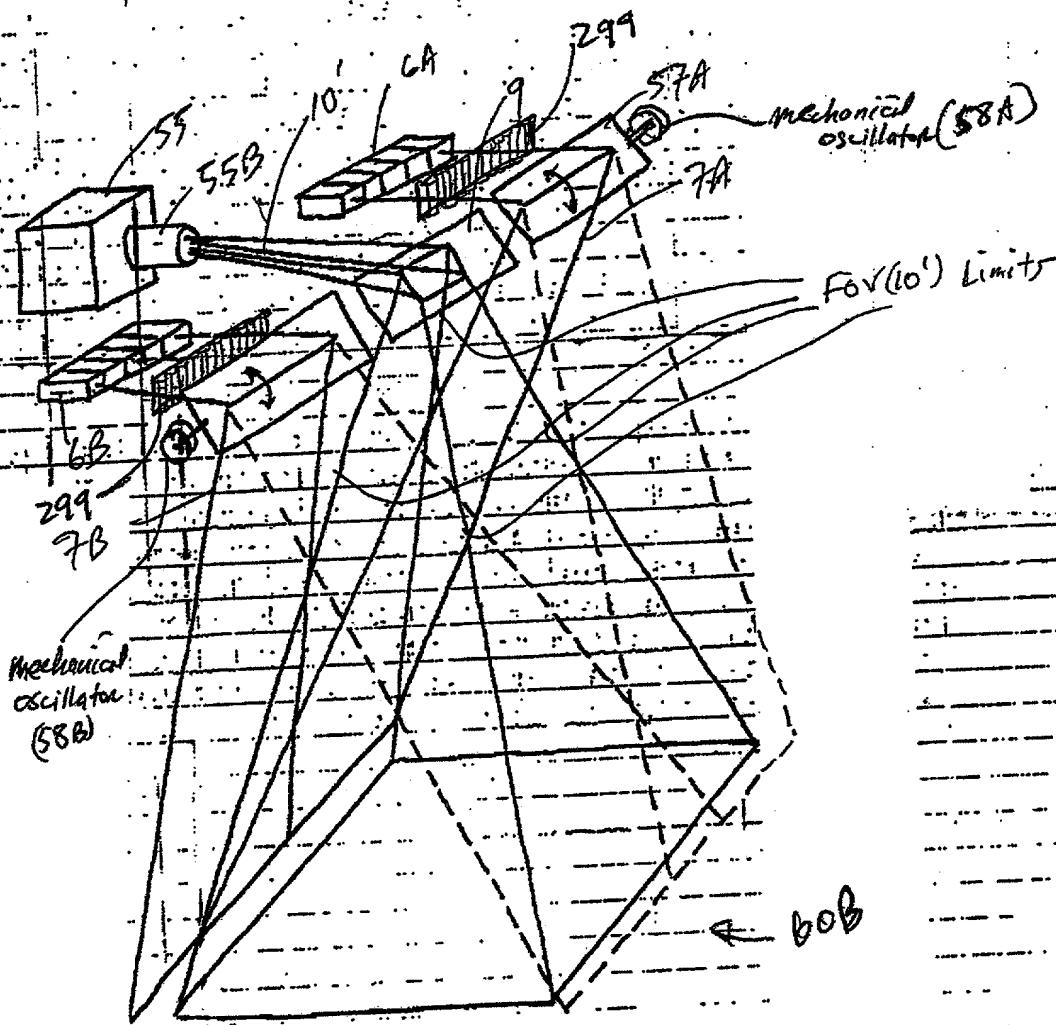
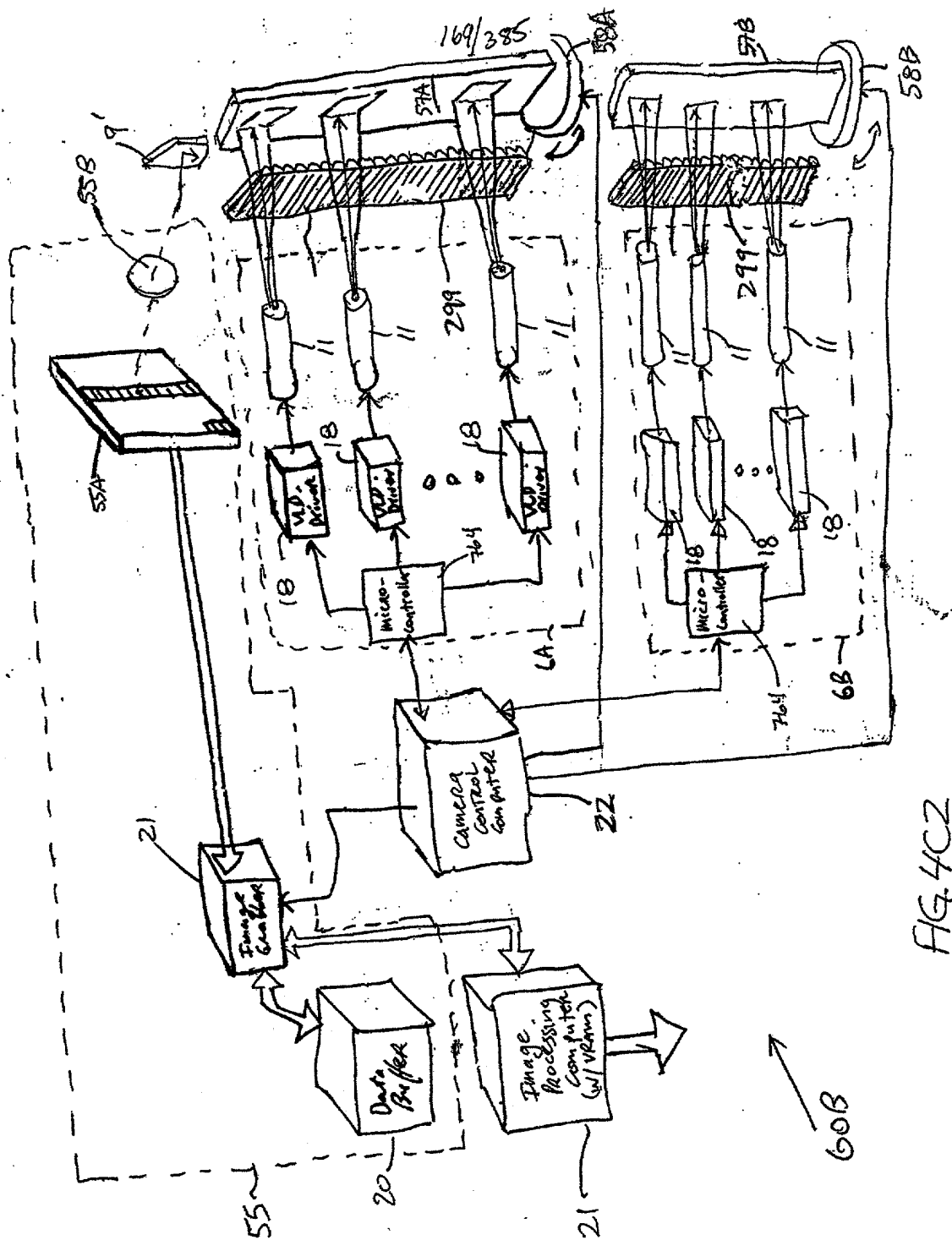


FIG 4C1



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1065462.020702

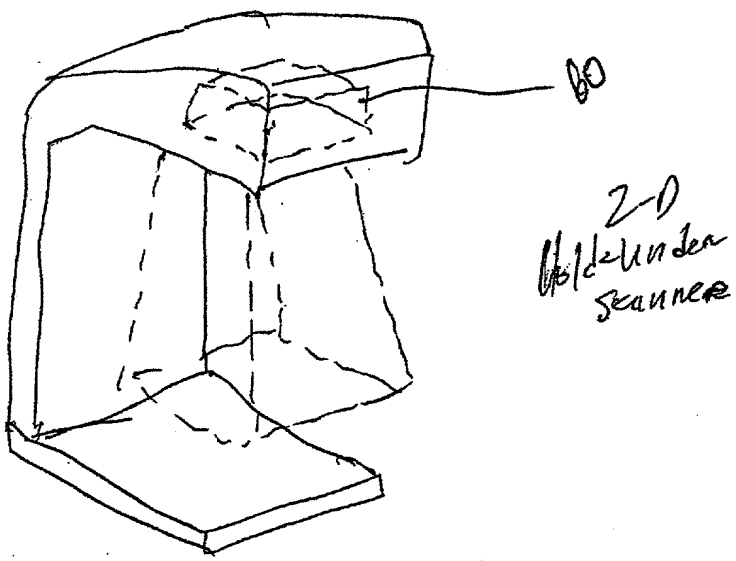


FIG. 4D

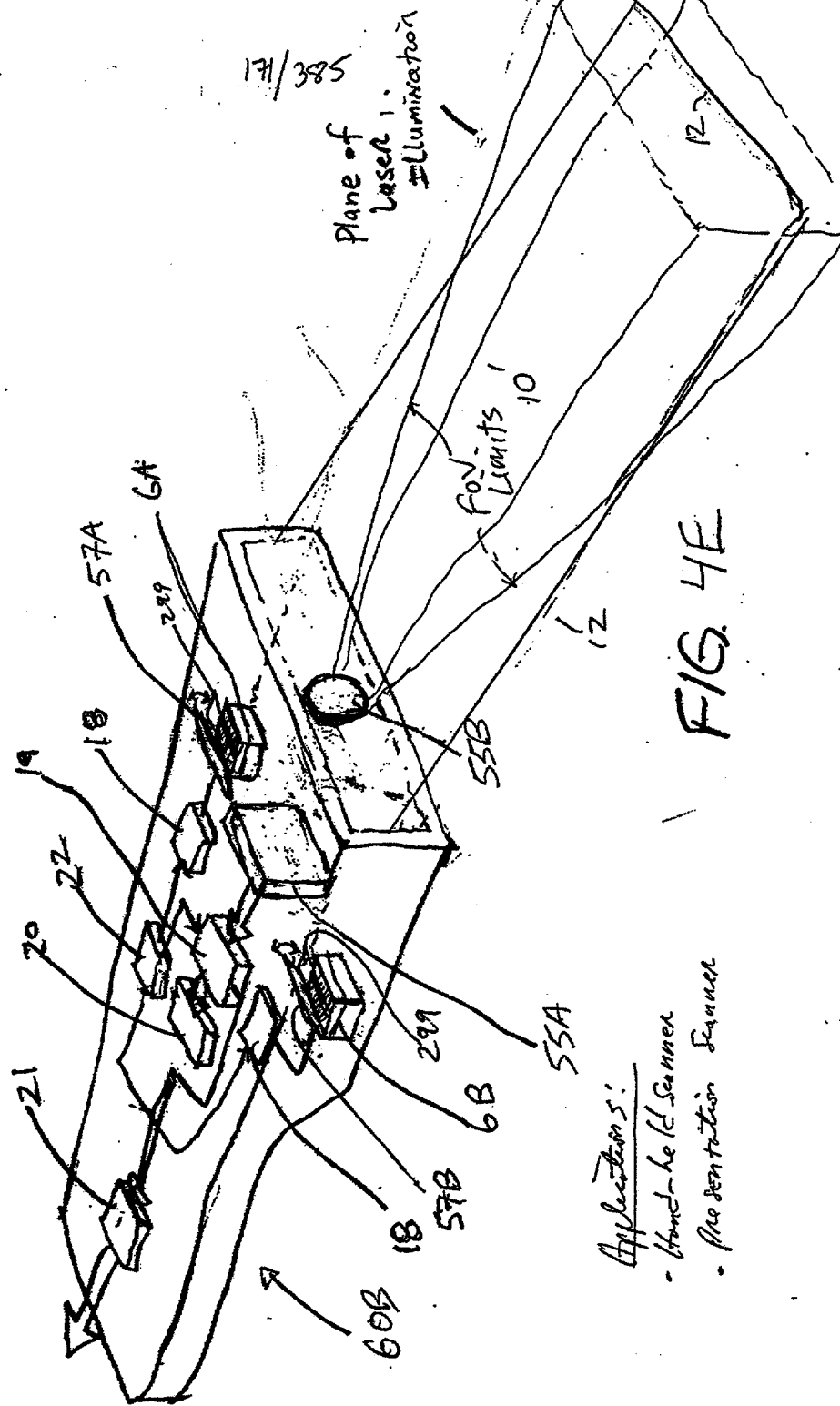


FIG. 4E

- Applications:
- Hand-held Scanner
  - Presentation Scanner

202020 23435001

CC

OC

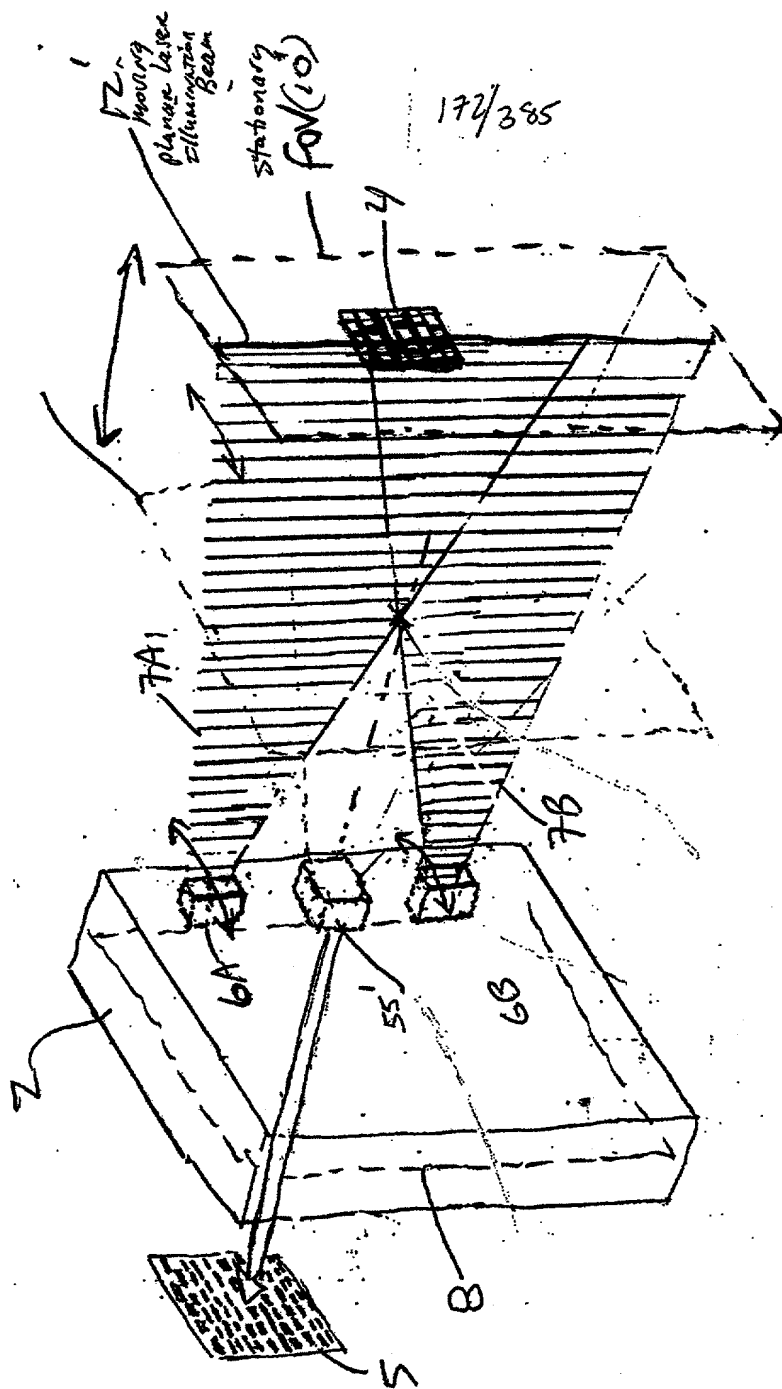


FIG. 5A



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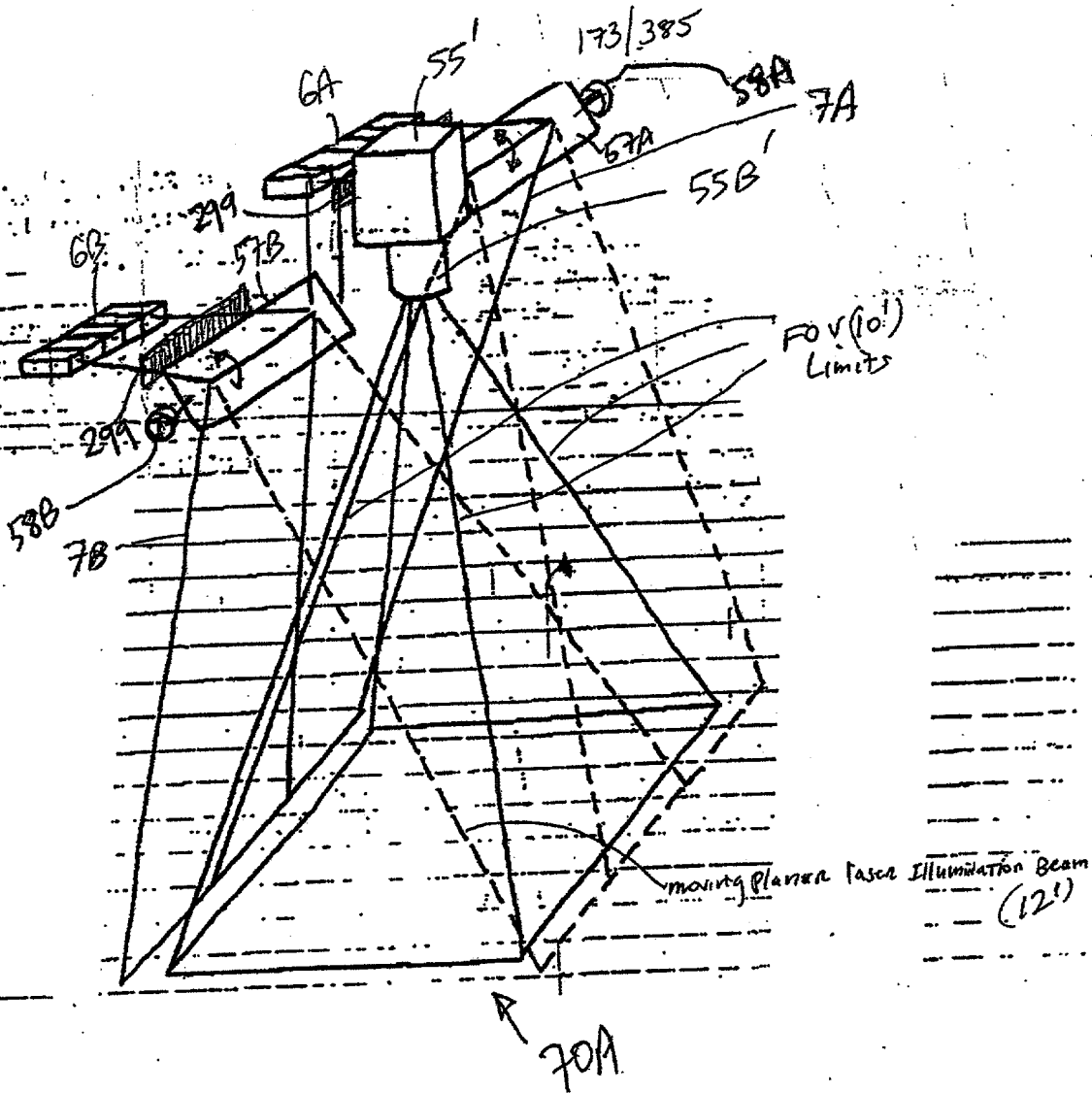


FIG 5B1

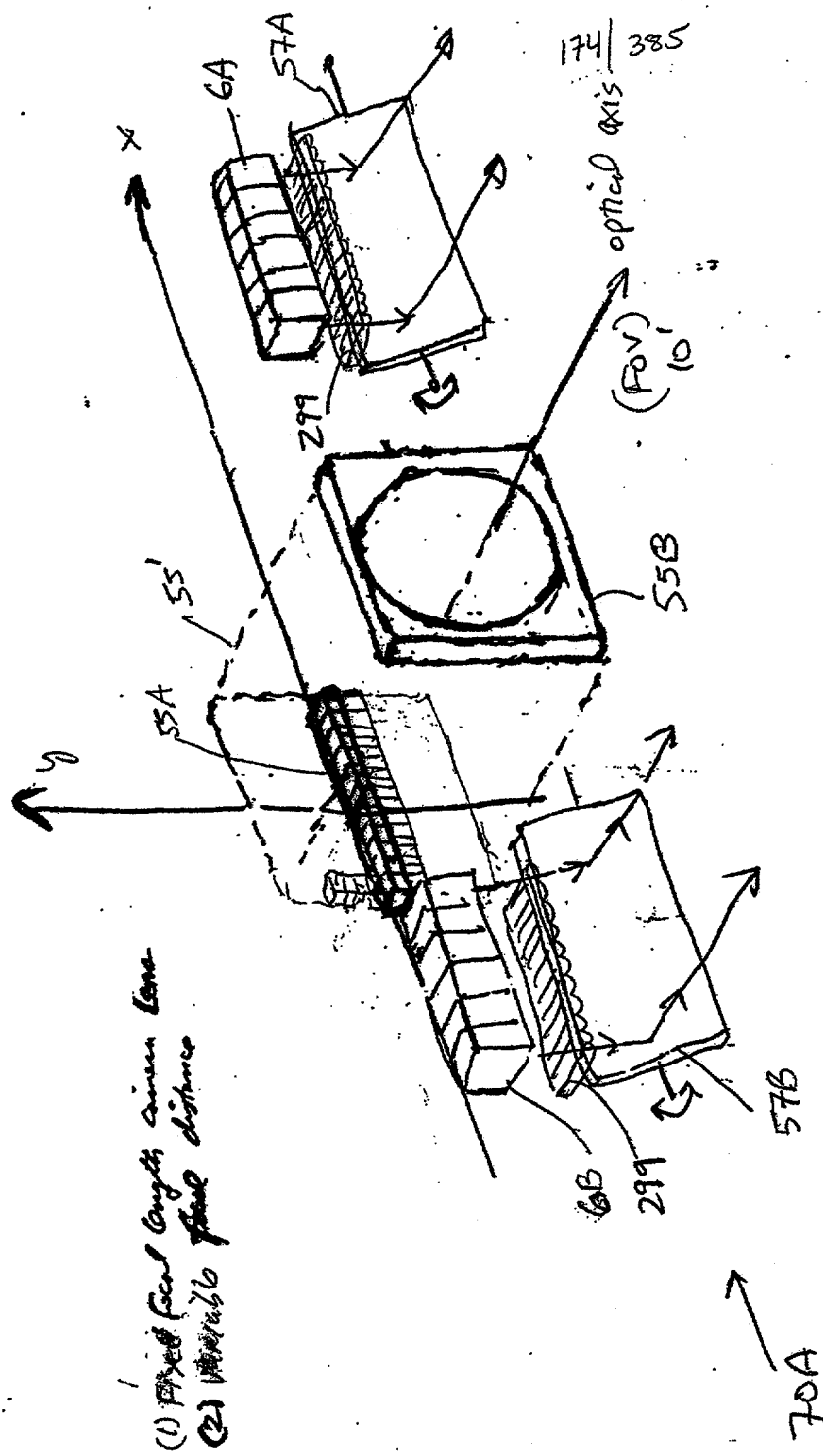


FIG. 5B2

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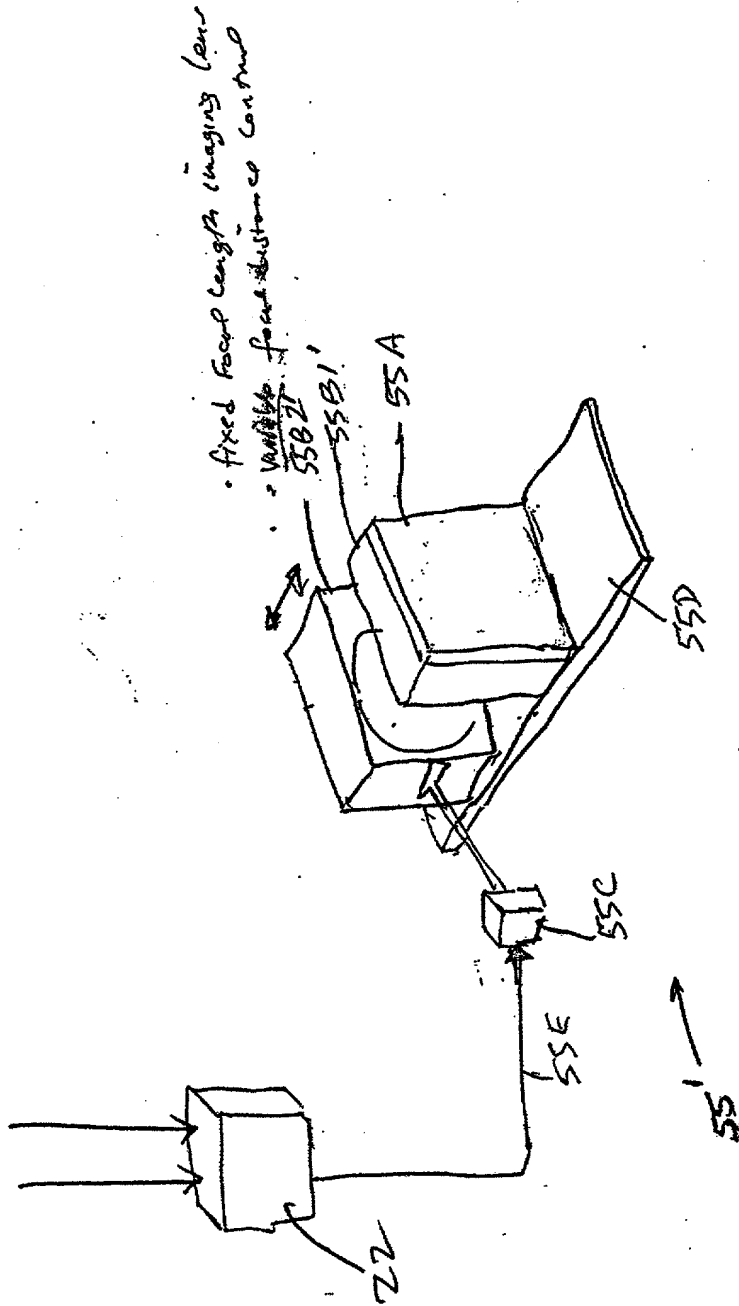


FIG. 5B4

20070201 22485001

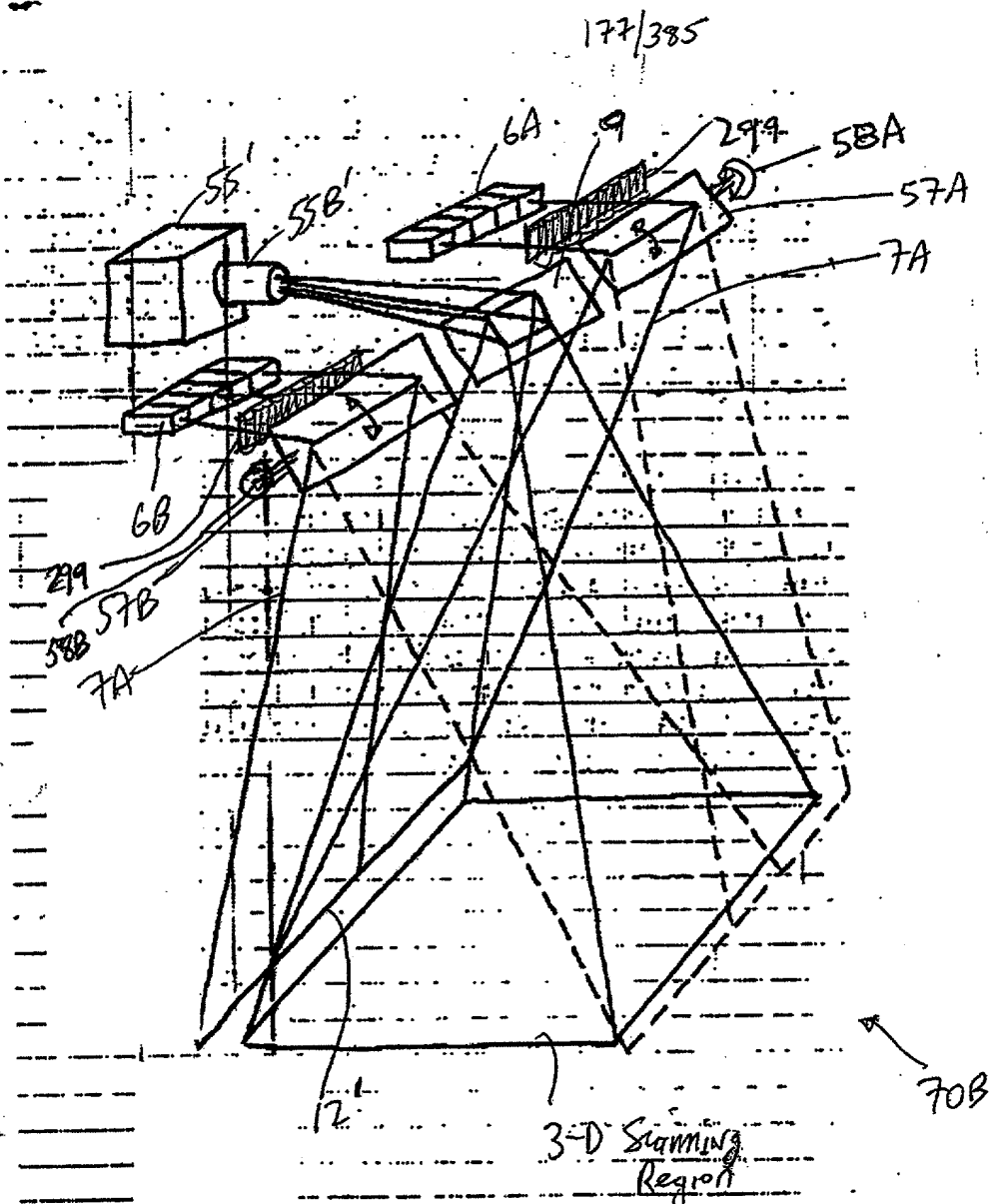


FIG. 5C1

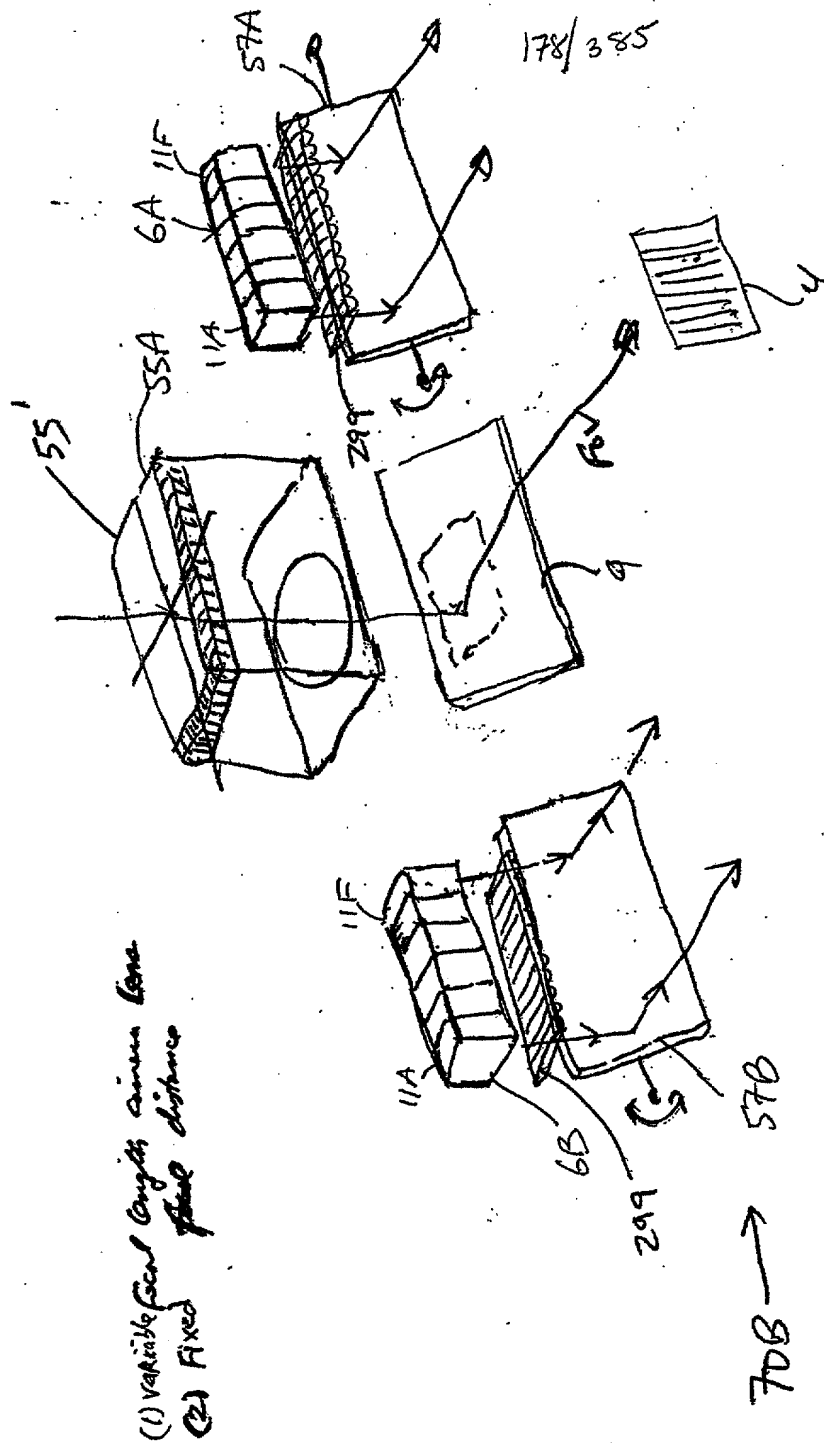


FIG. 5C

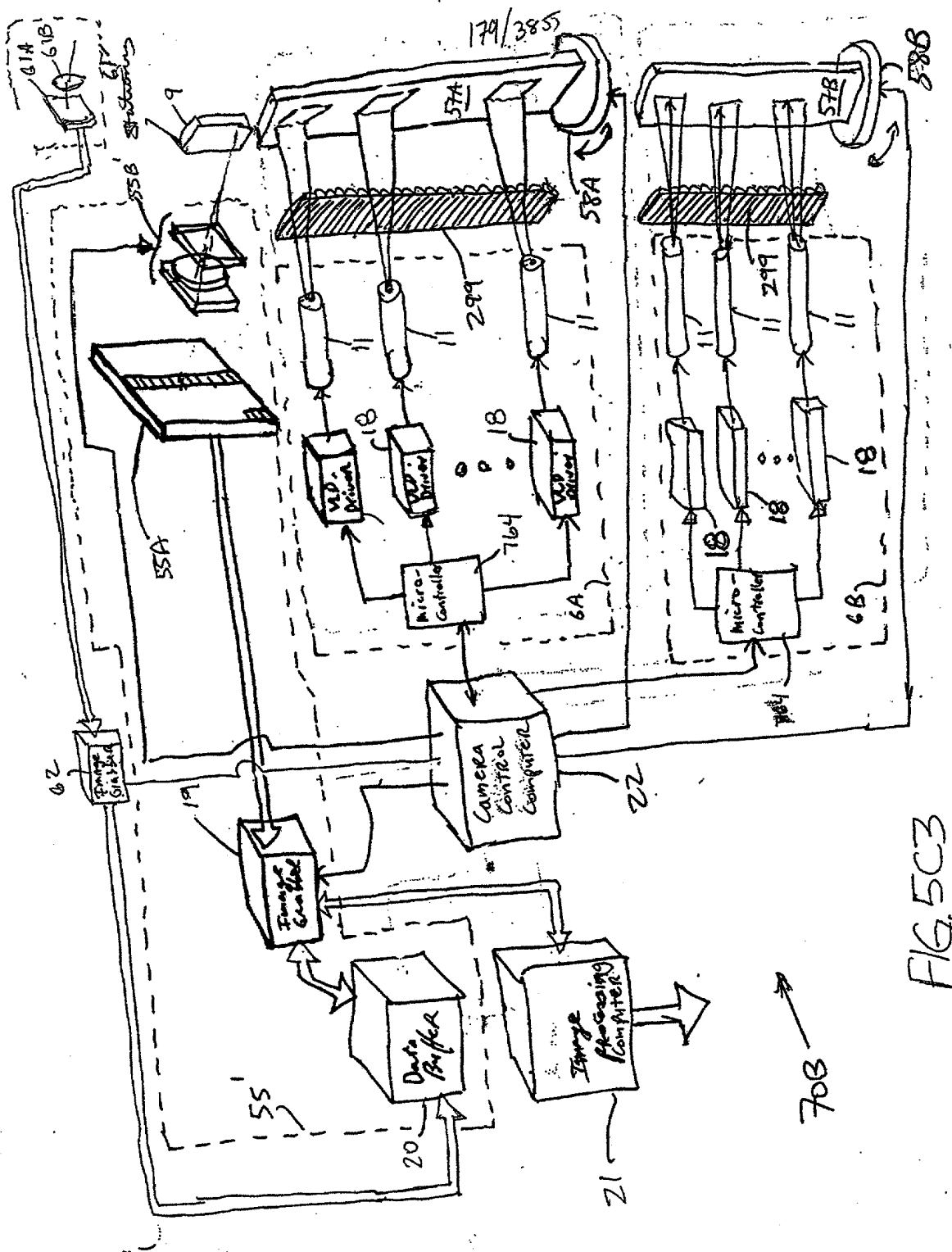


FIG. 5C3

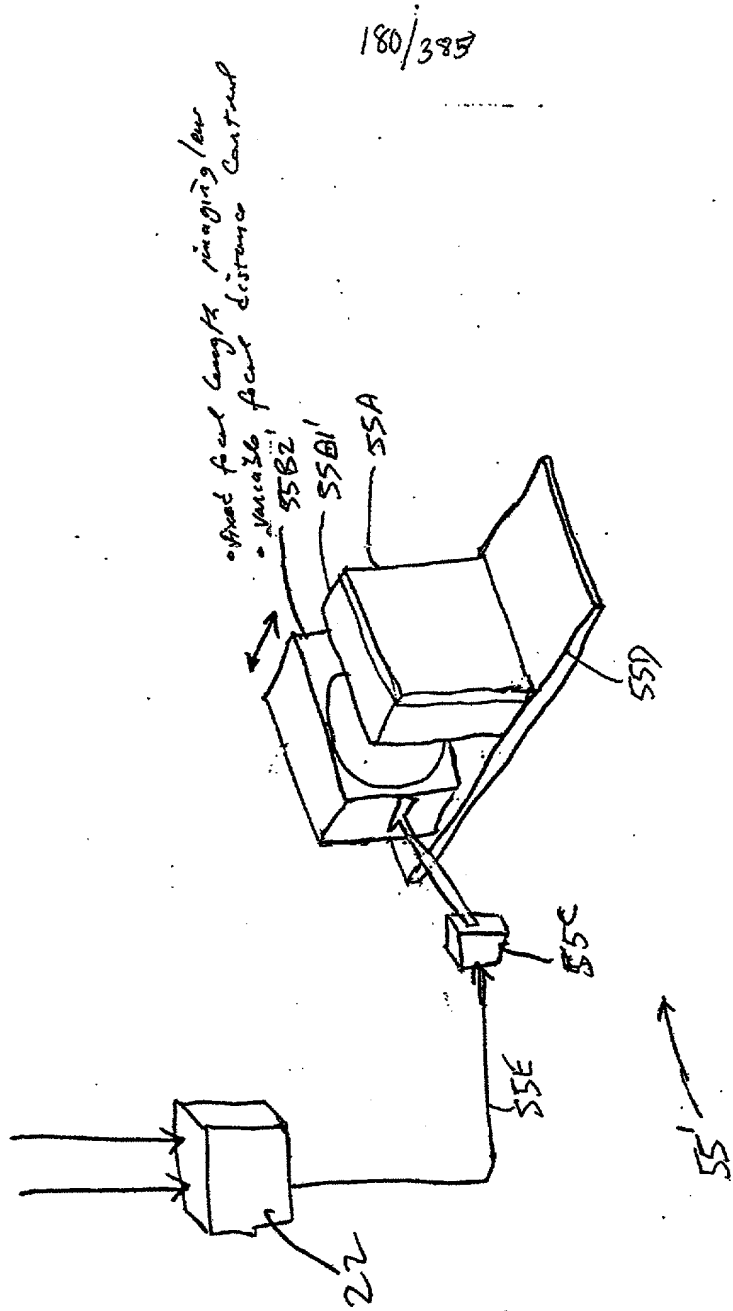


FIG. 5C4



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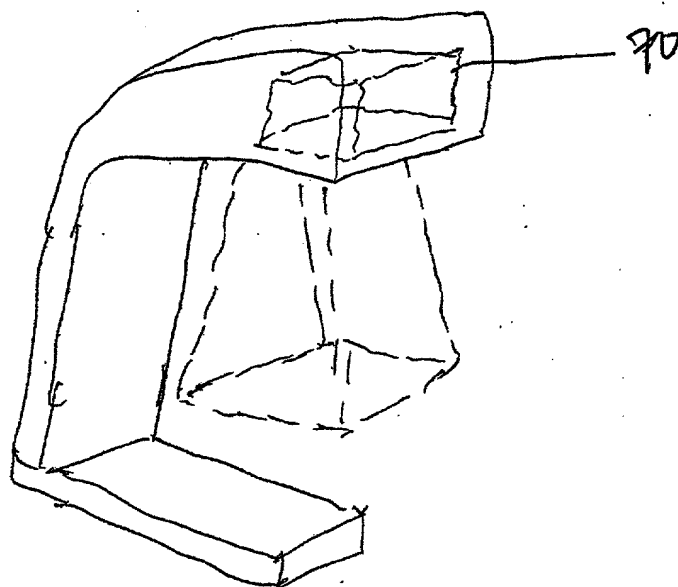


FIG. 5D

10068462.020702

CC

OC

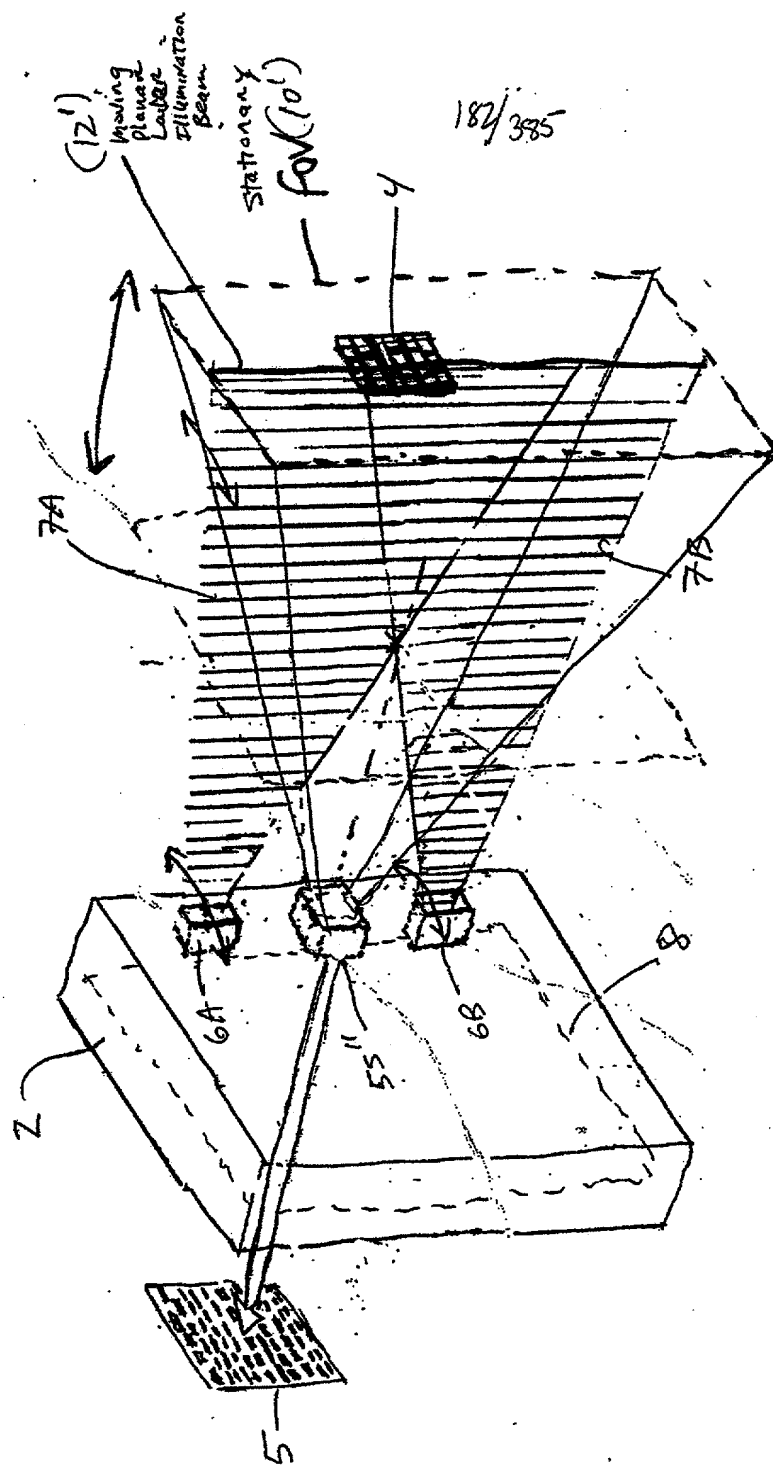


FIG. 6A

10068462.020702

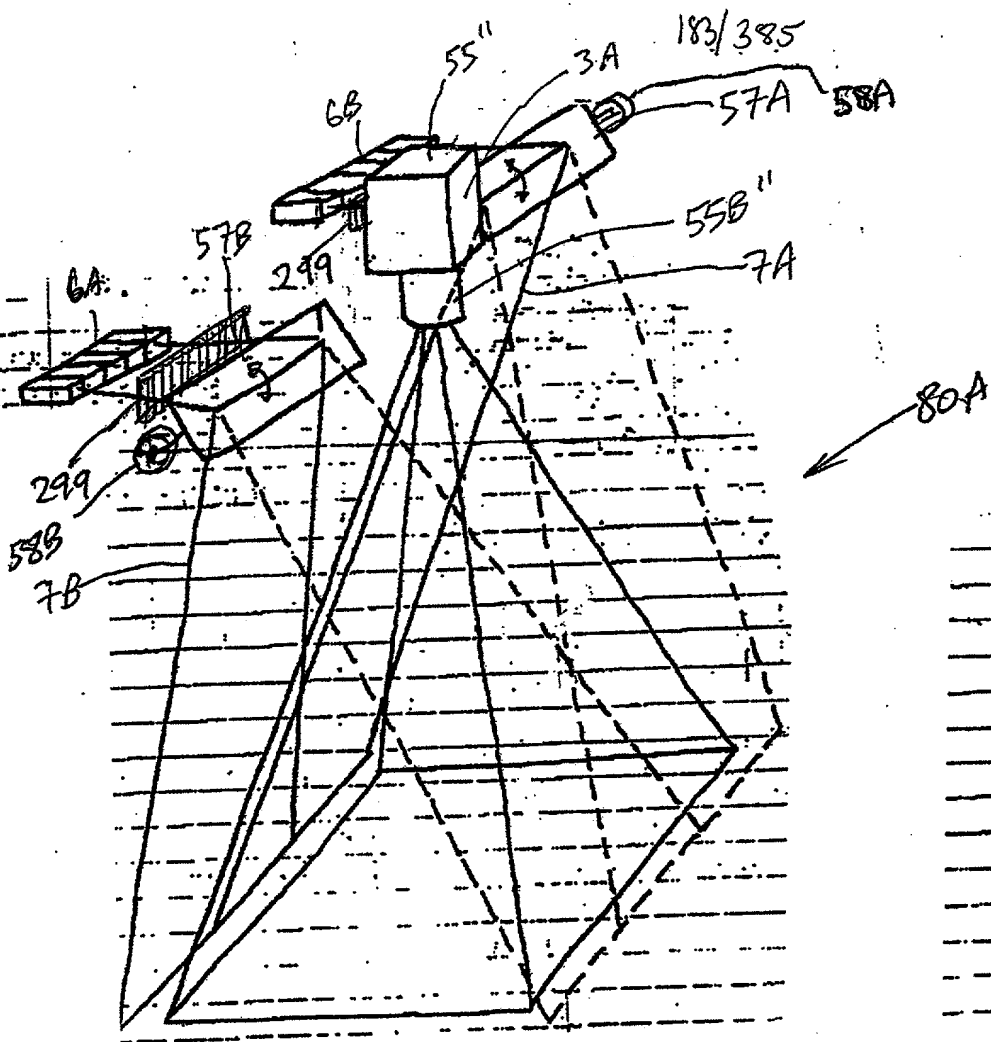


FIG. 6B1

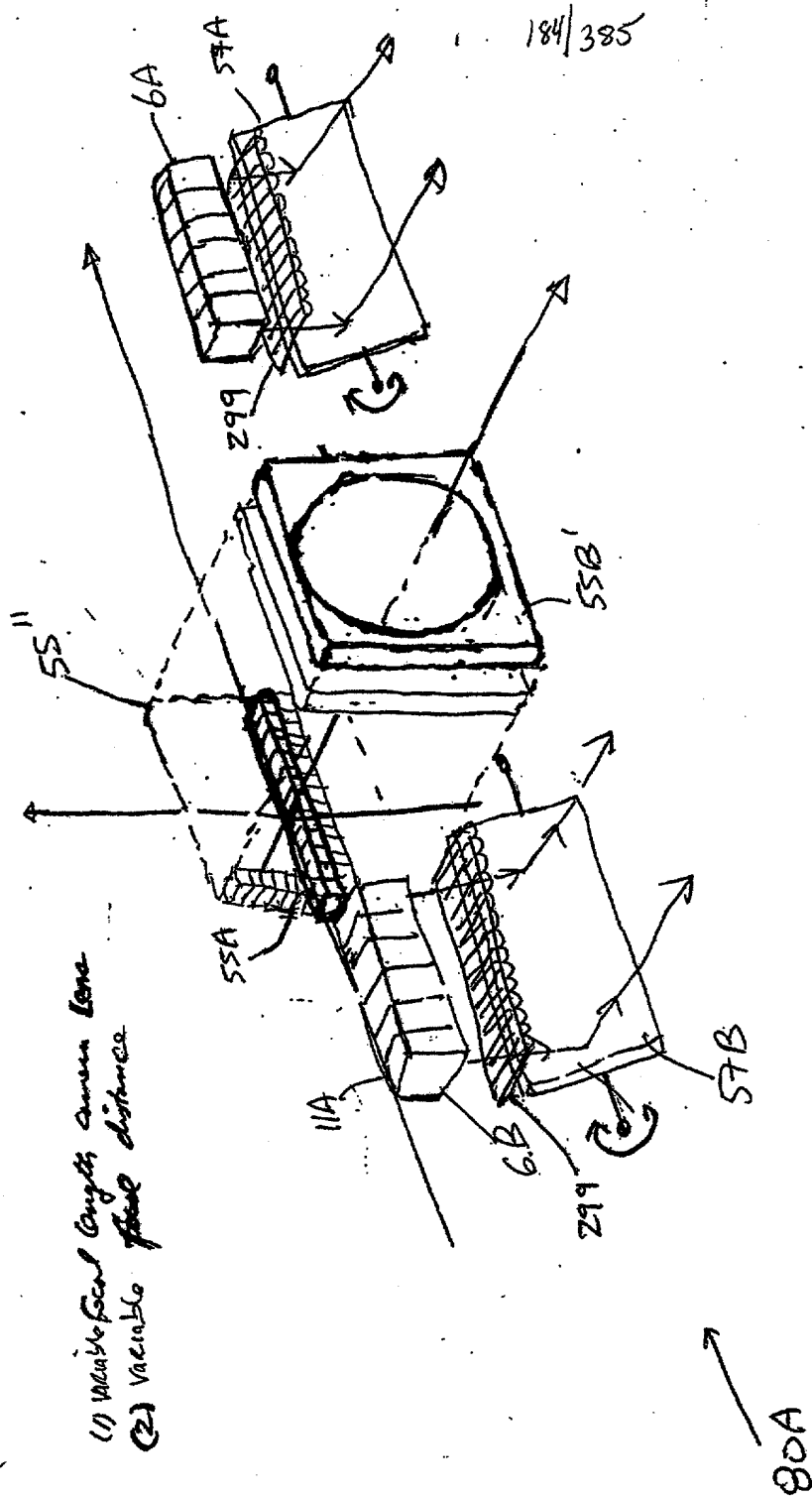


FIG. 6B2

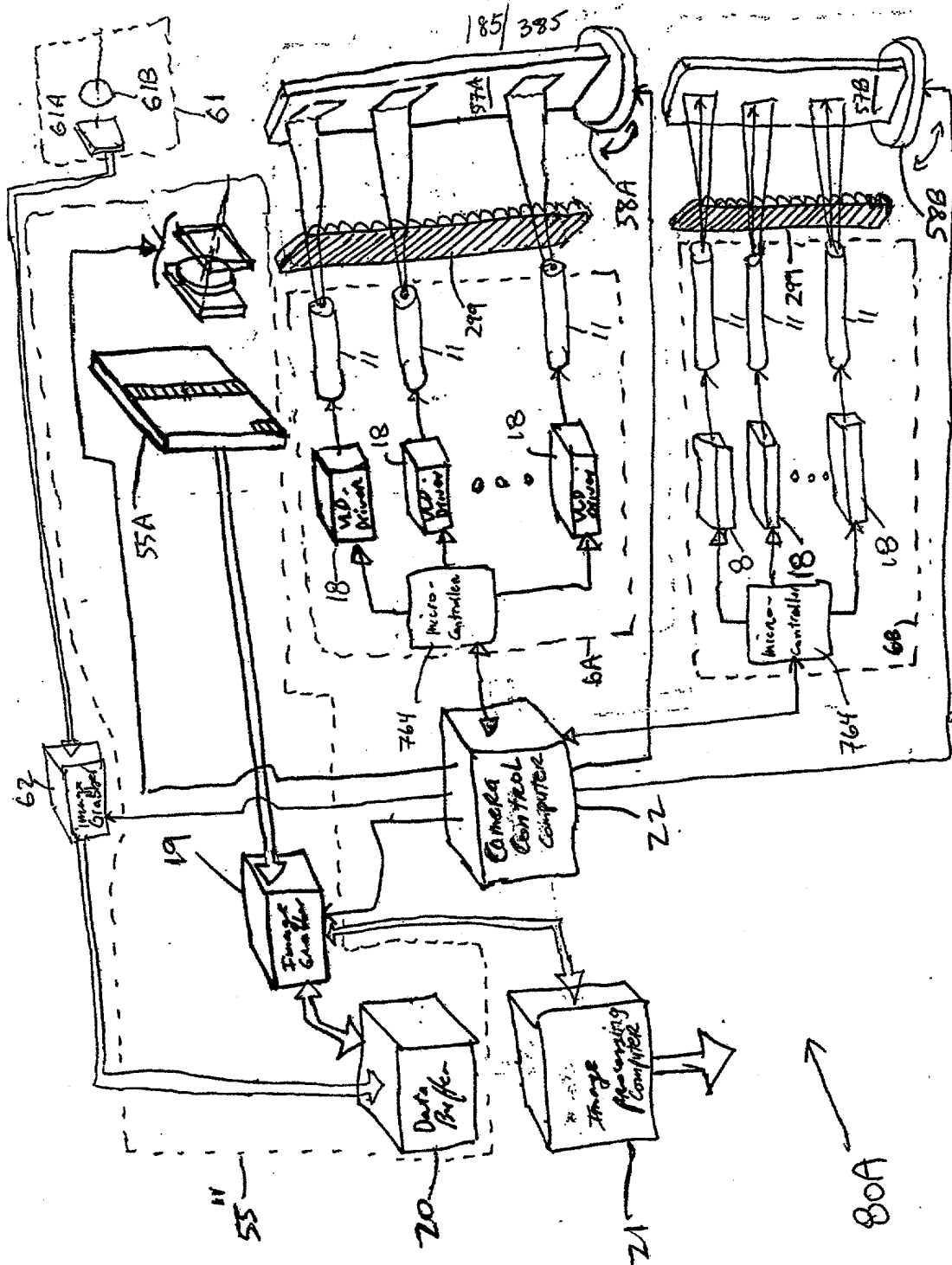


FIG. 6B3

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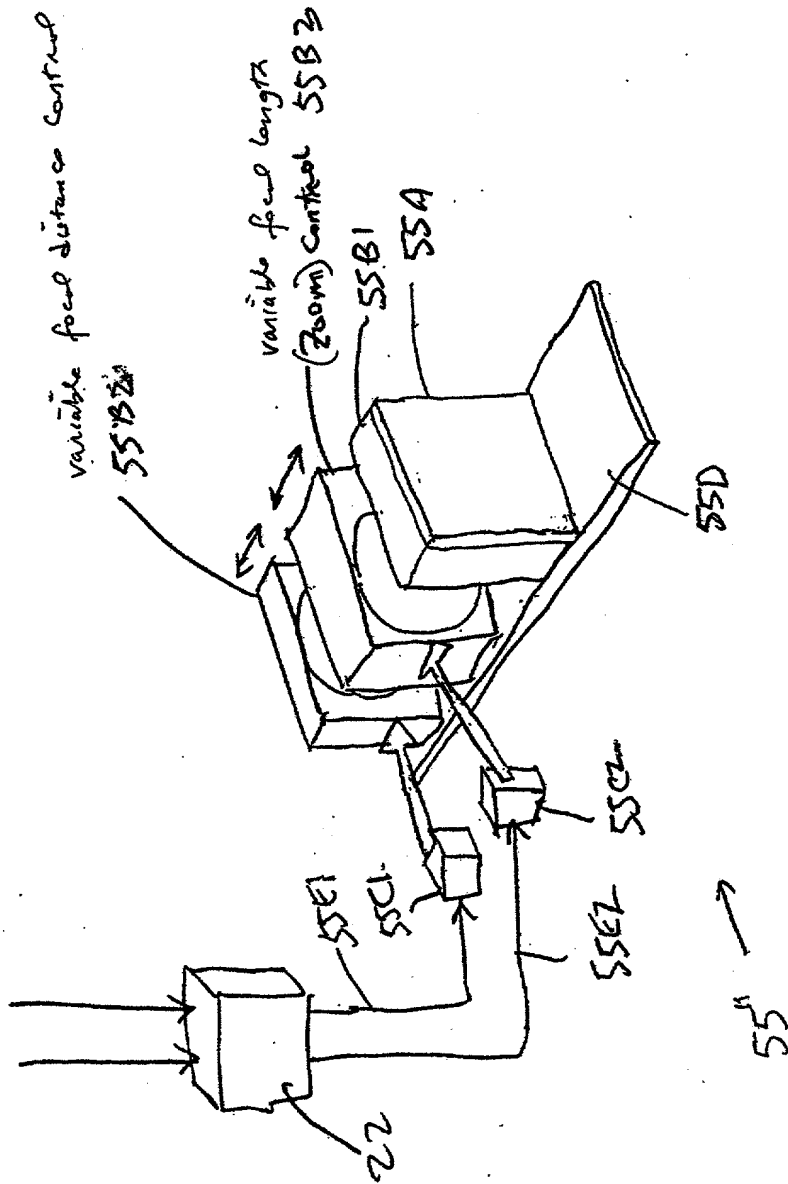


FIG. 6B4

202020 29439001

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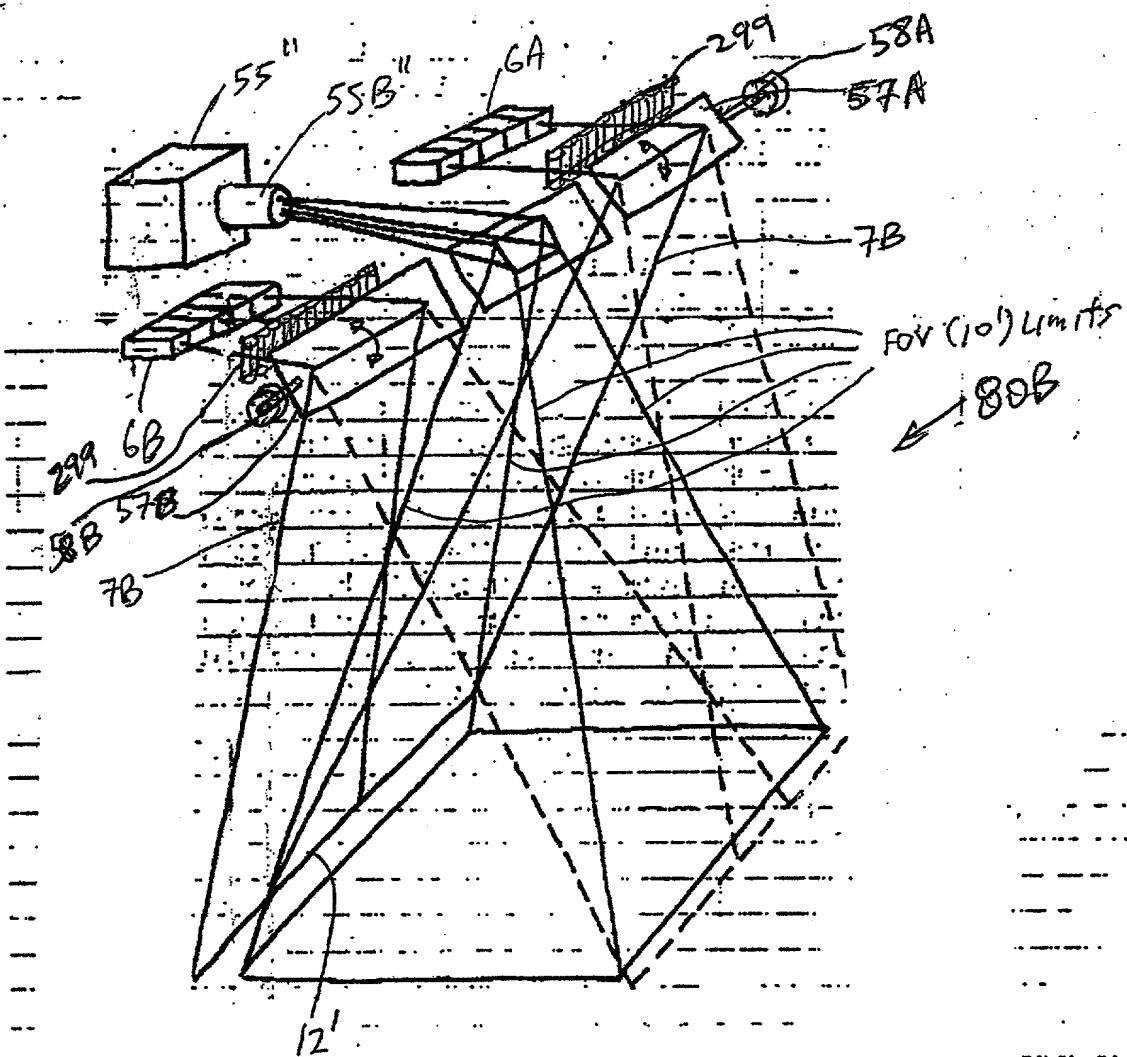


FIG. 6C1

(1) variable focal length camera lens  
(2) variable focal distance



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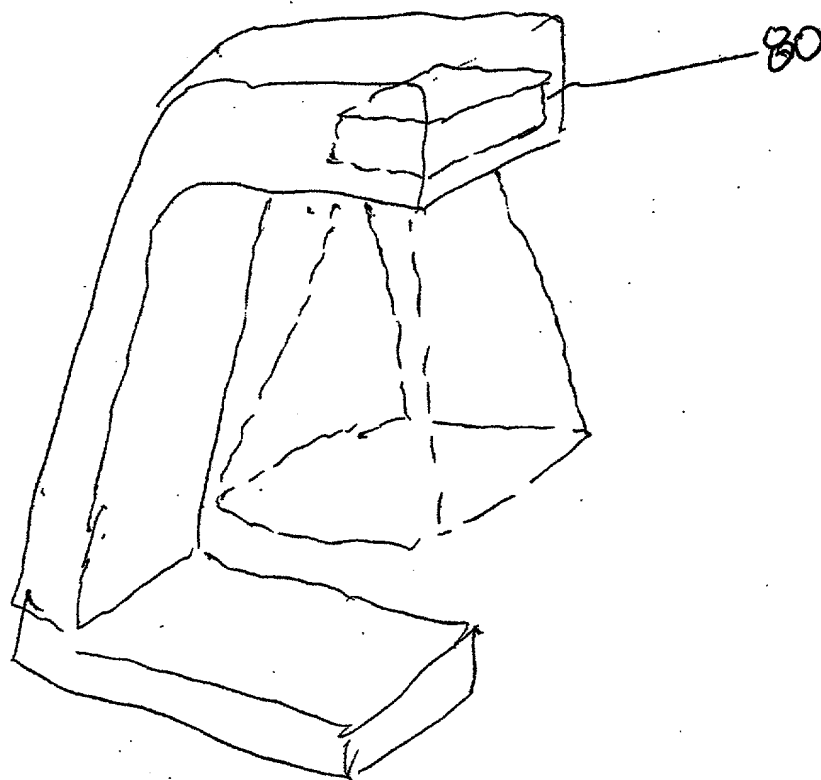


FIG. 6C5

10068462.020702

20200201 29489001

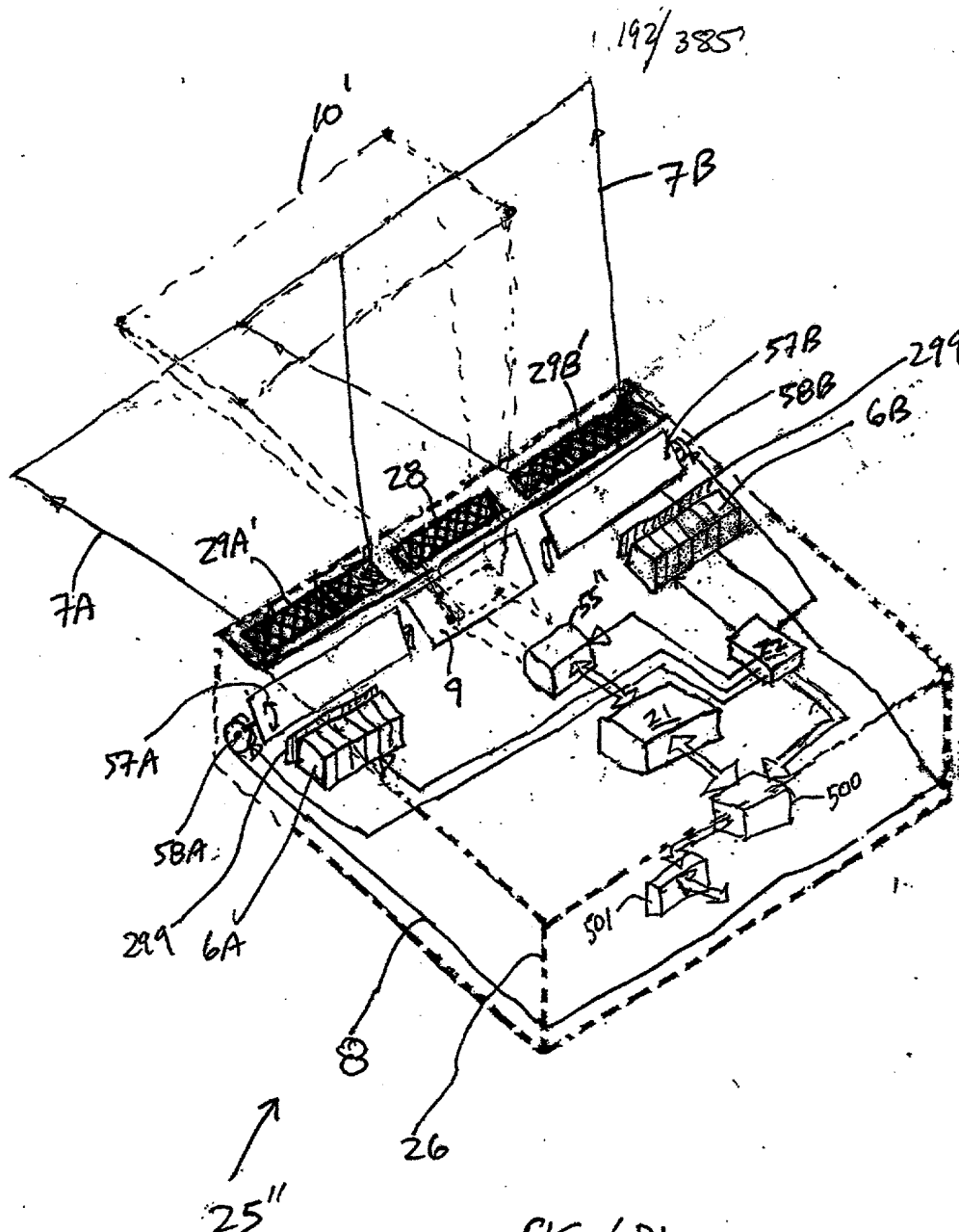


FIG. 6D1

20070201 2948900F

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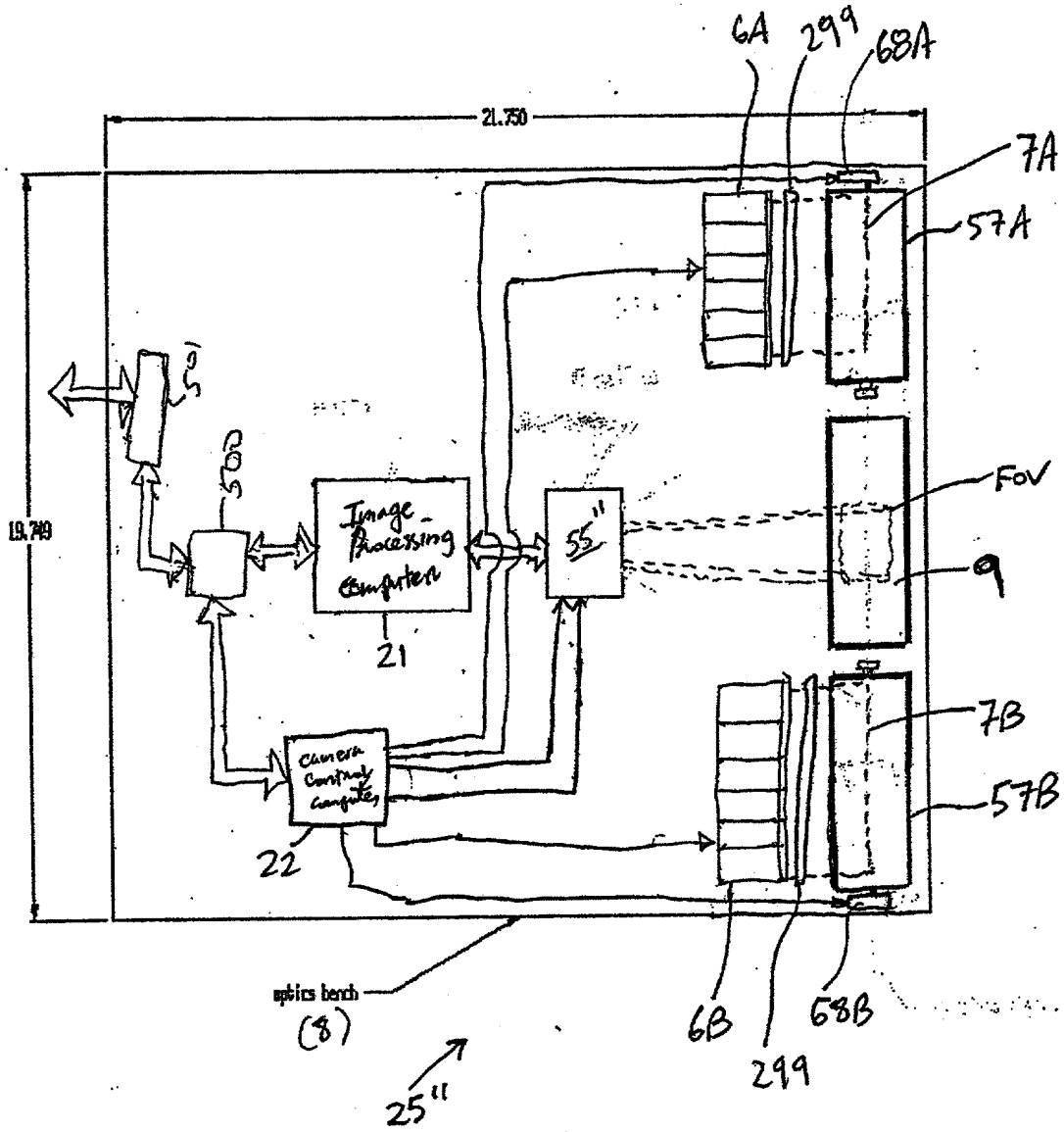


FIG. 6DZ

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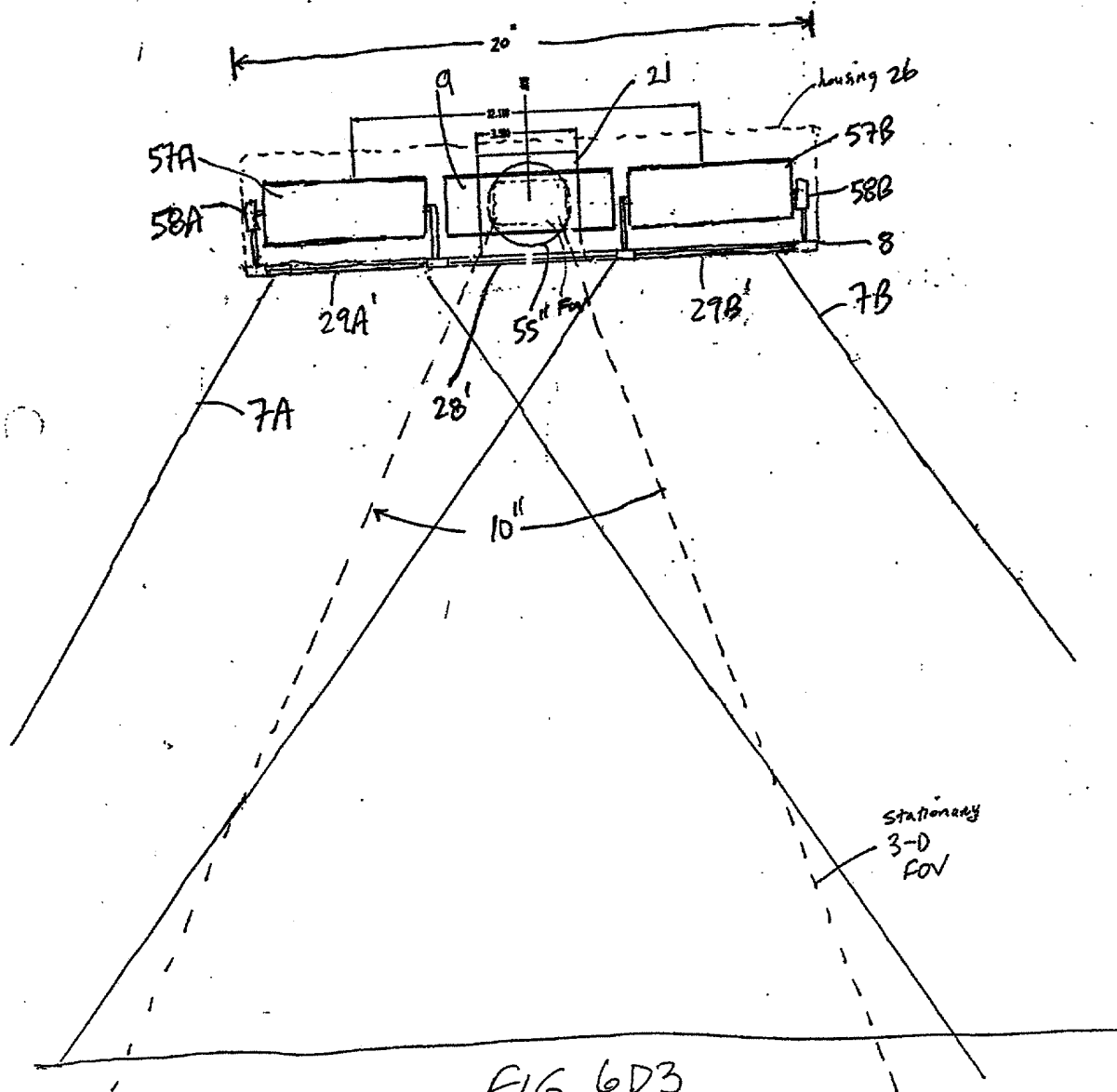
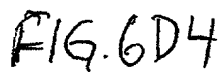


FIG. 6D3

202020-29439001

[illegible]

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Variable FOV

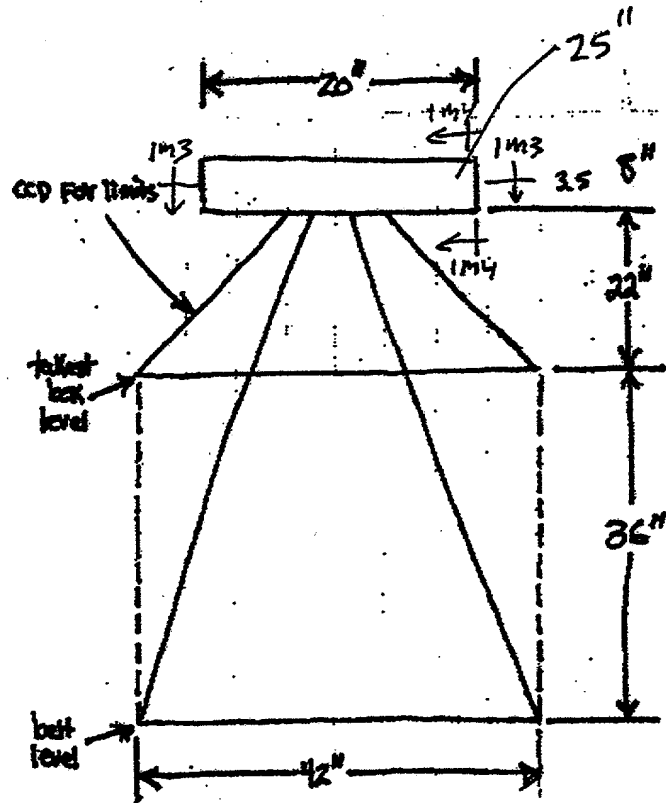


FIG. 6D5

1058462-020702



10063463.020702

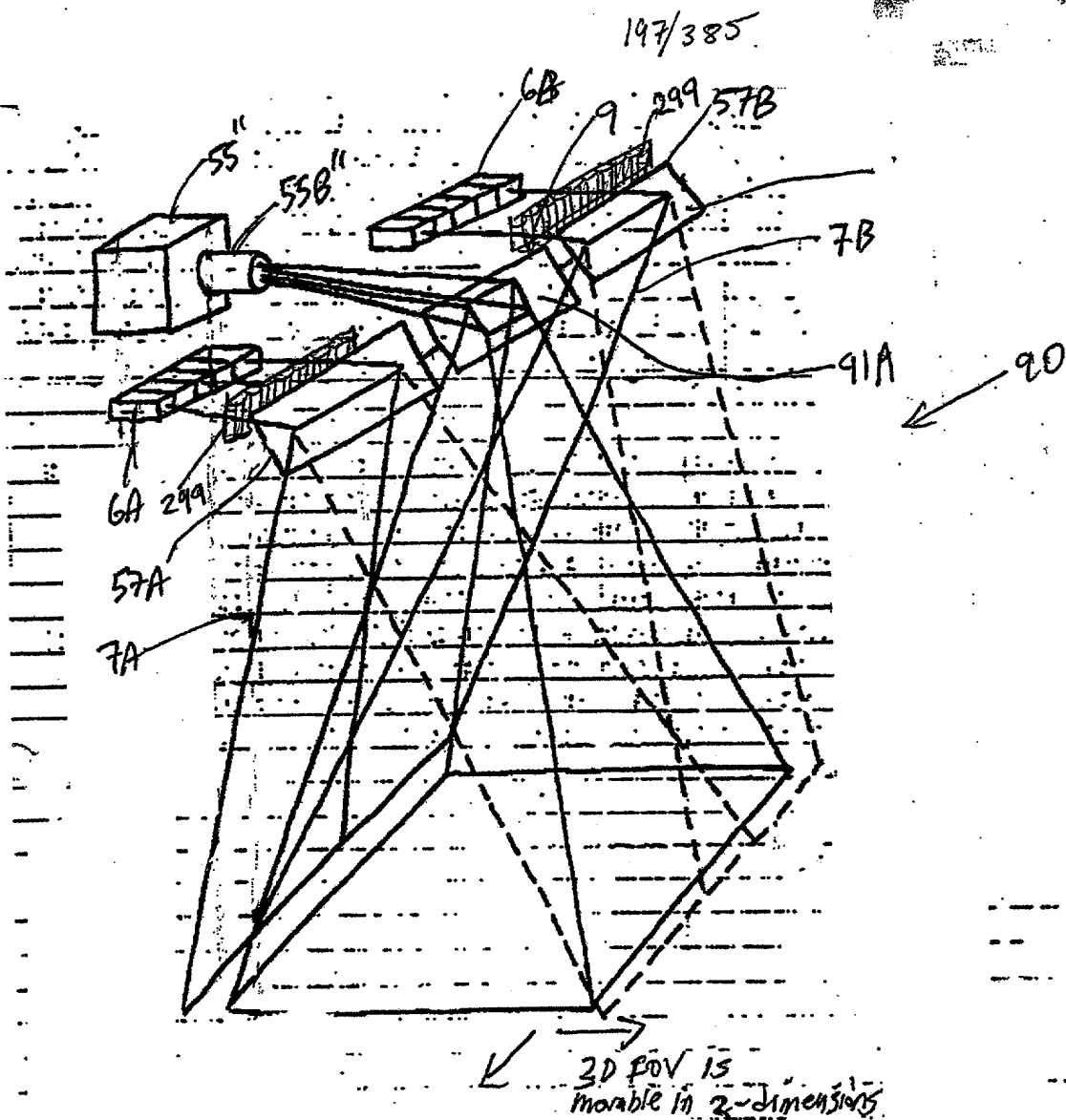


FIG 6E1

Q



FIG. 6f-2

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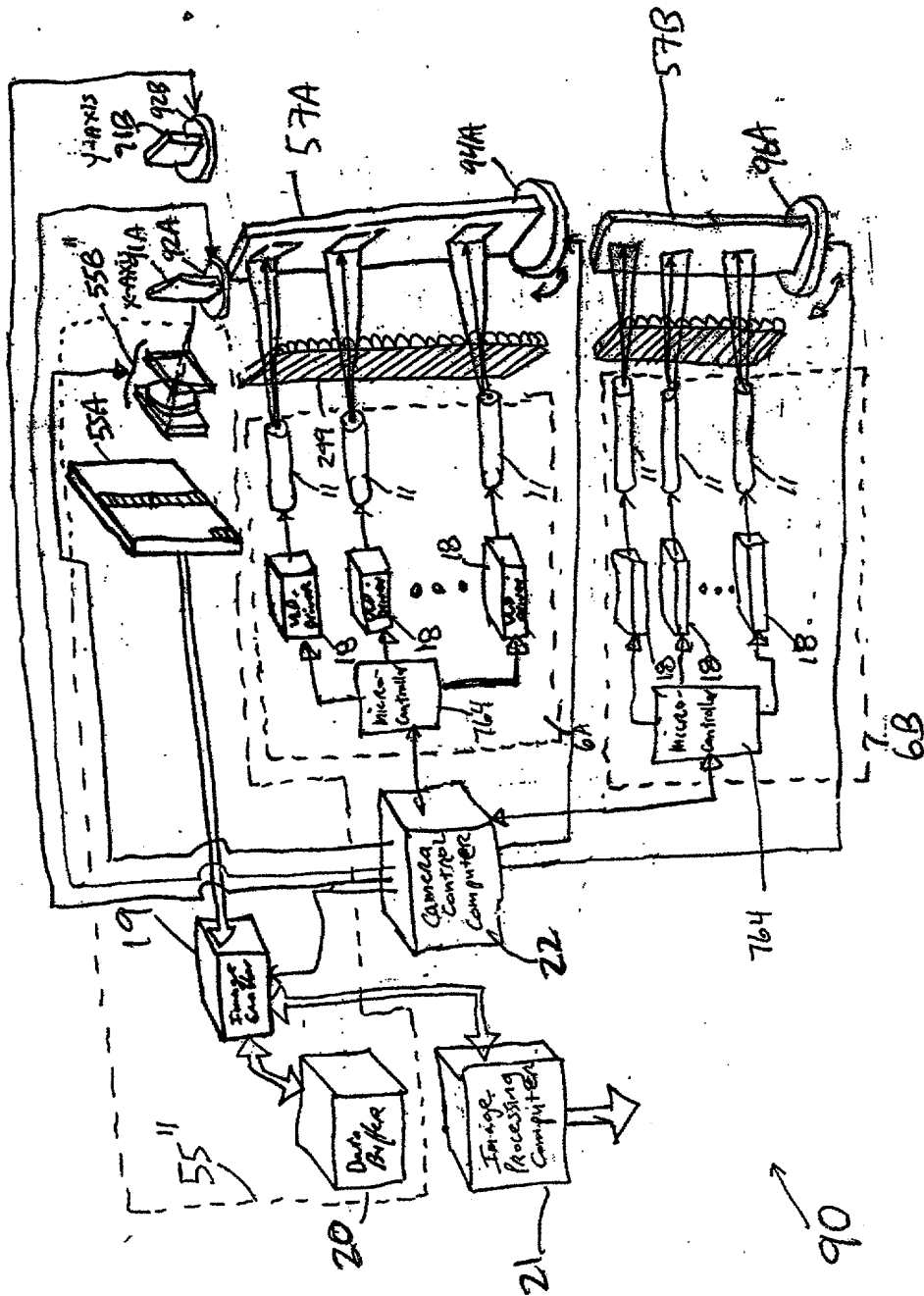


FIG. 6E3

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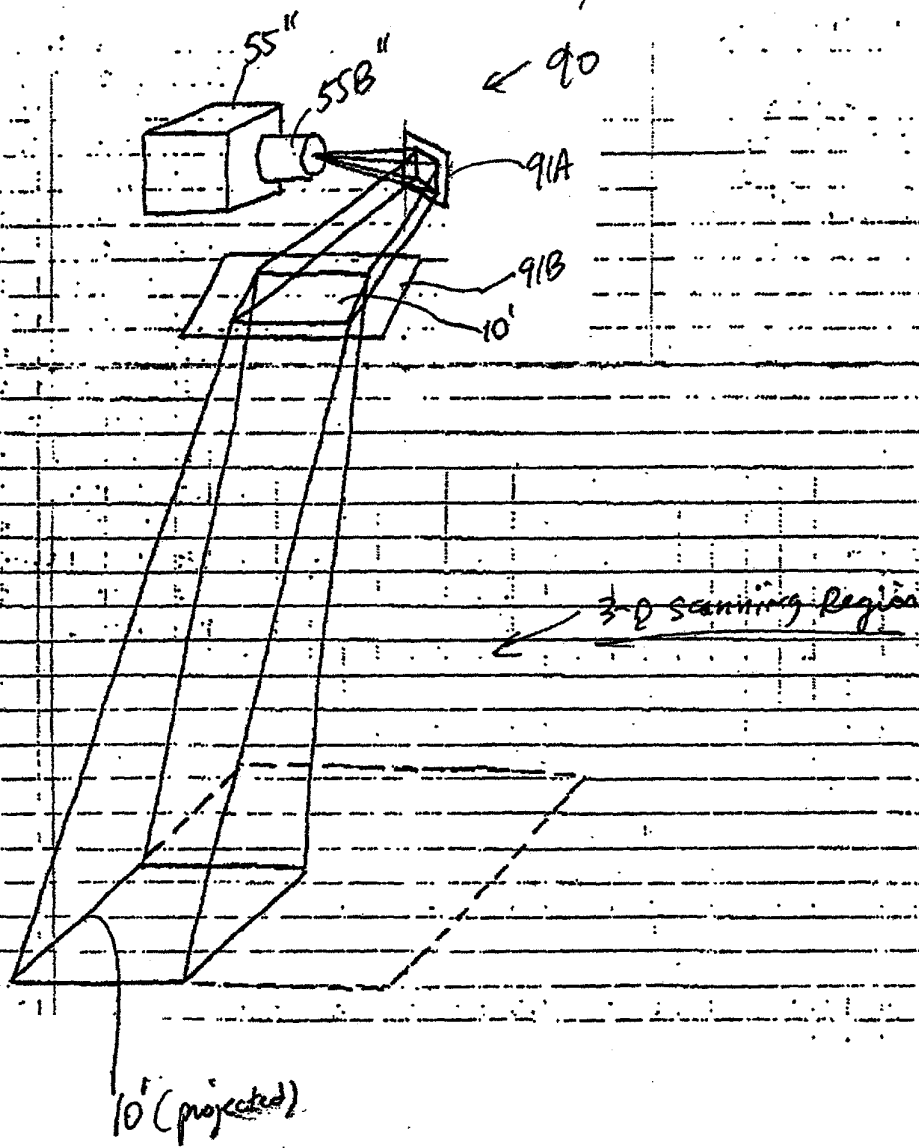
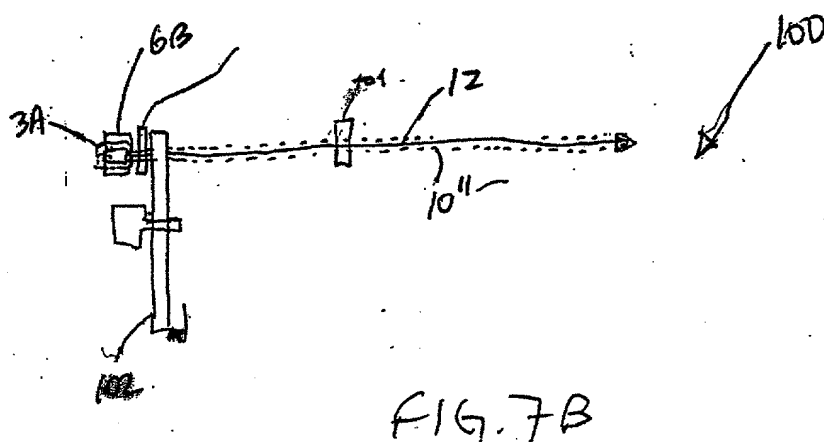
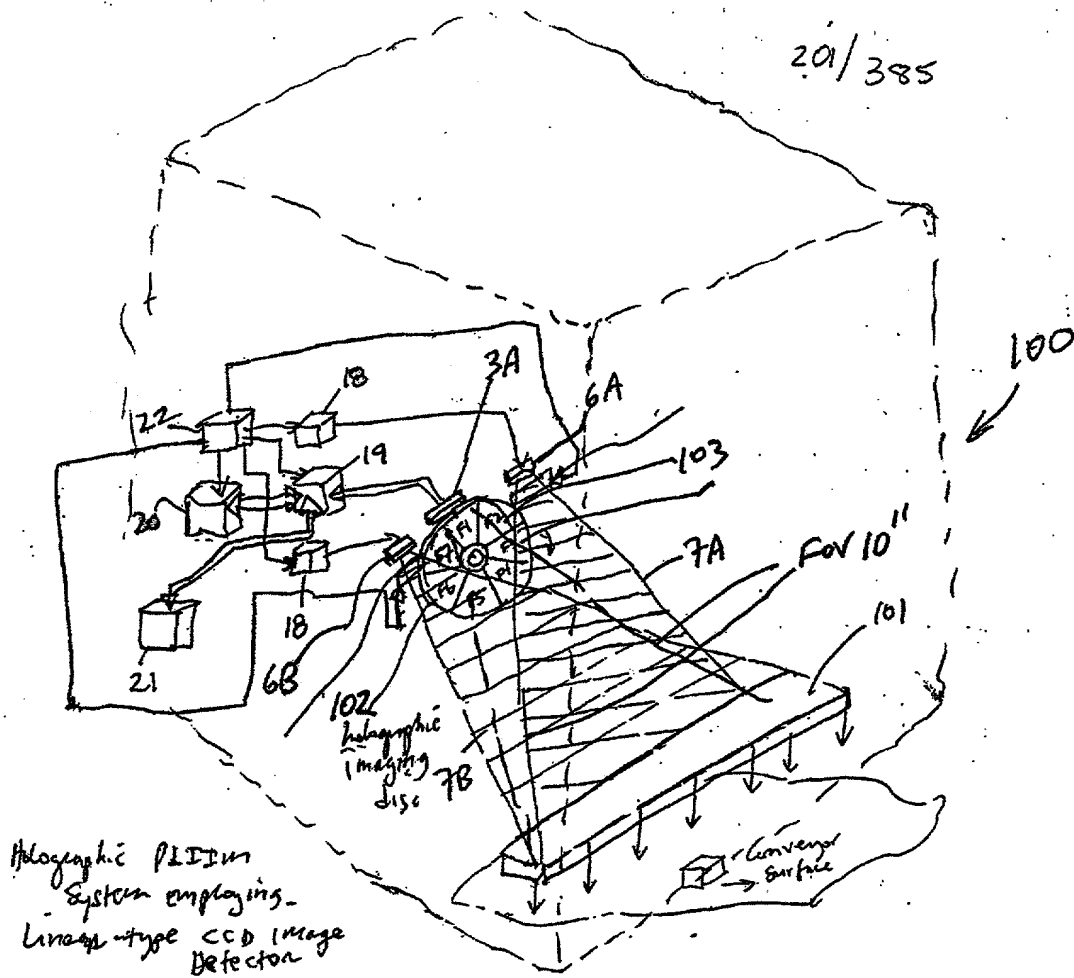


FIG. 6E4

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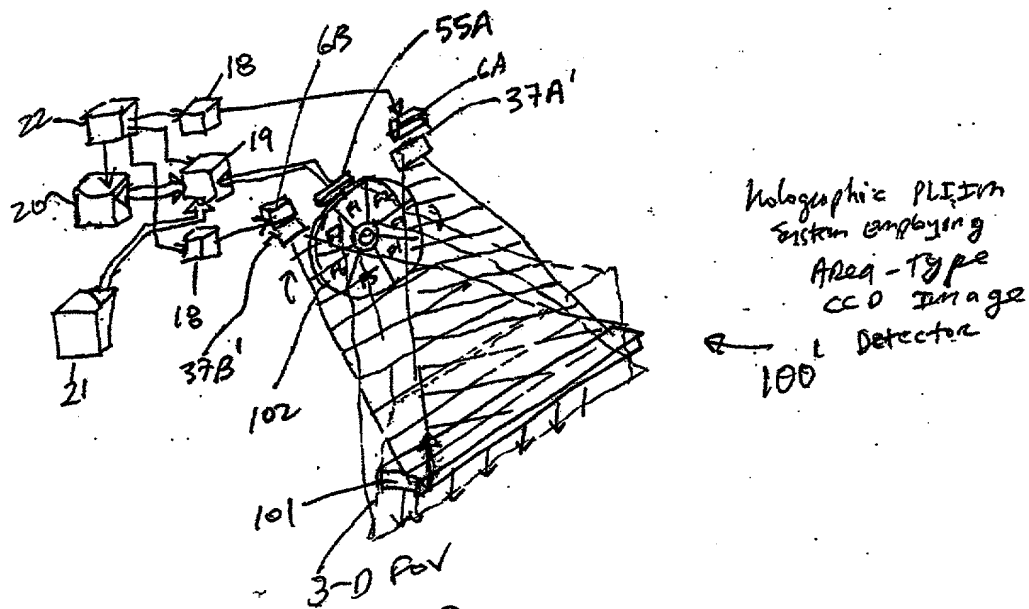


FIG. 8A

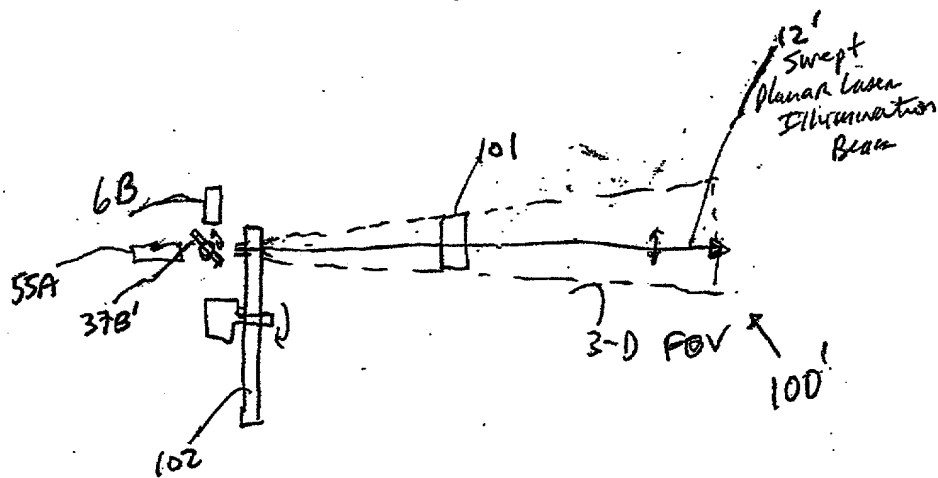


FIG. 8B

1006462.020702

1-D CCD SCANNER EMBODIMENT

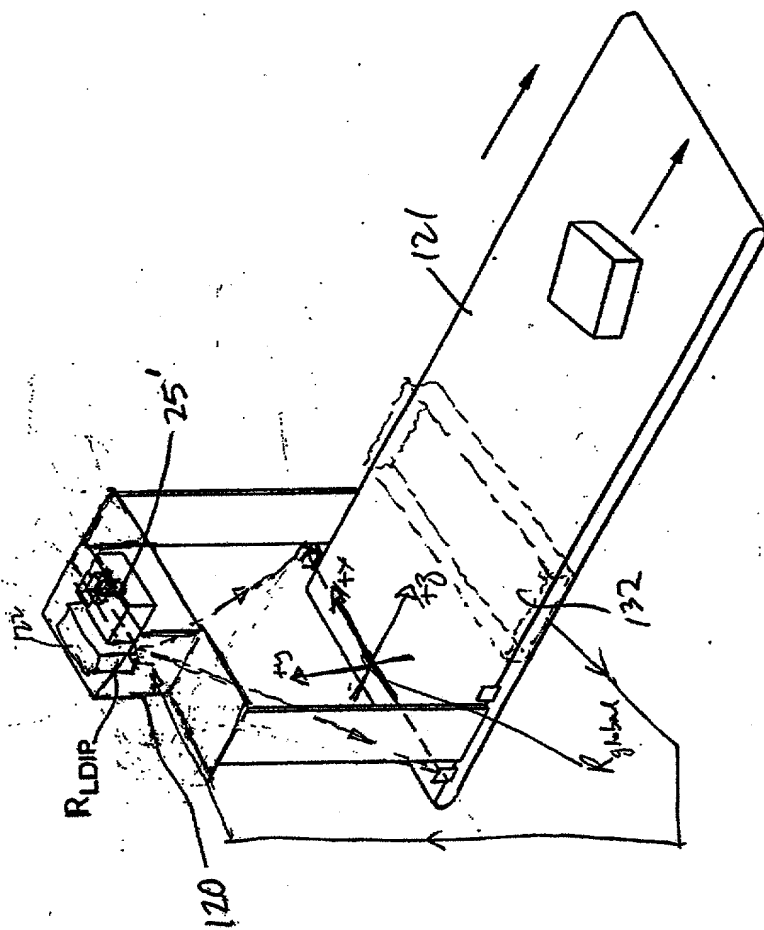
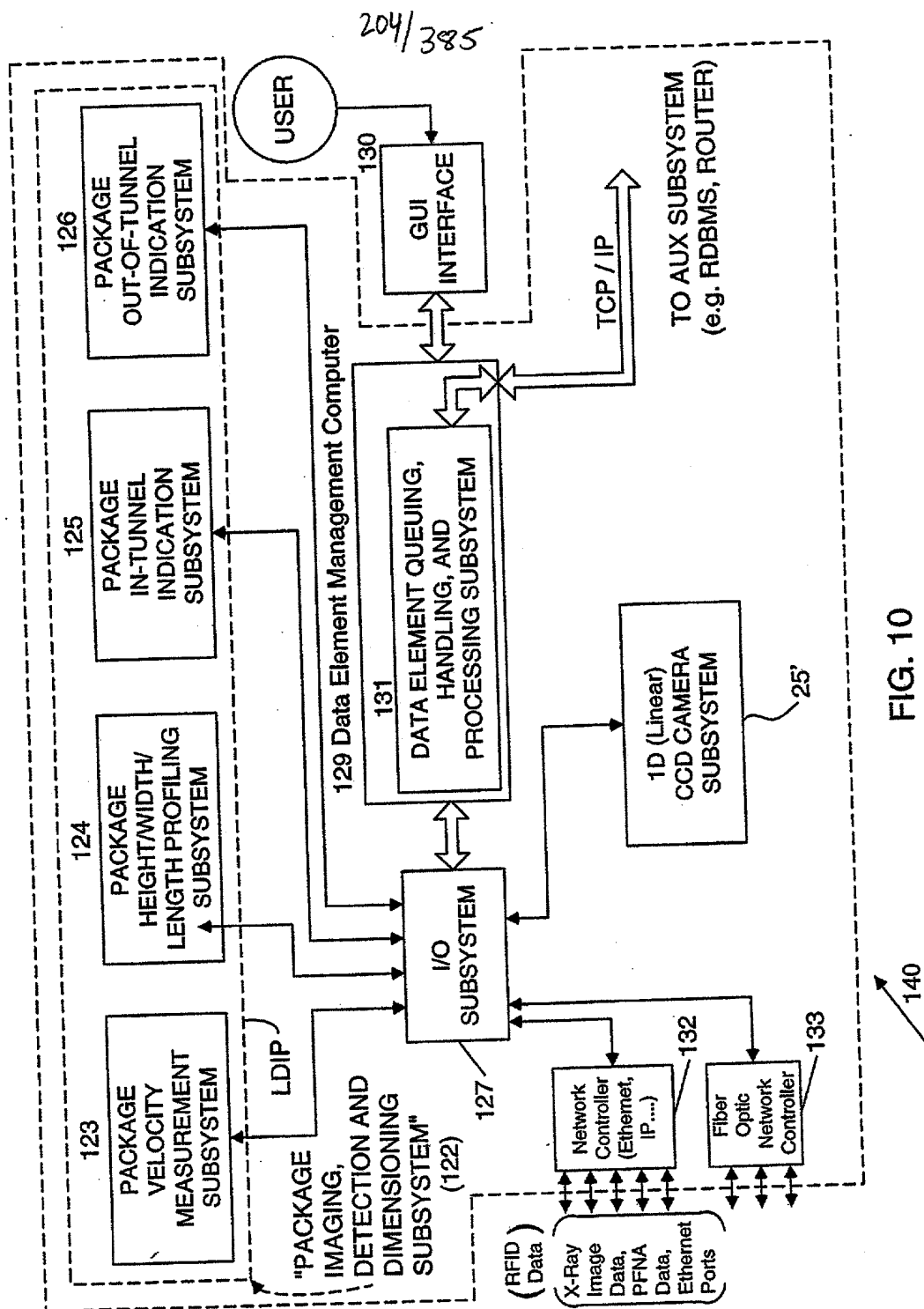


FIG. 9





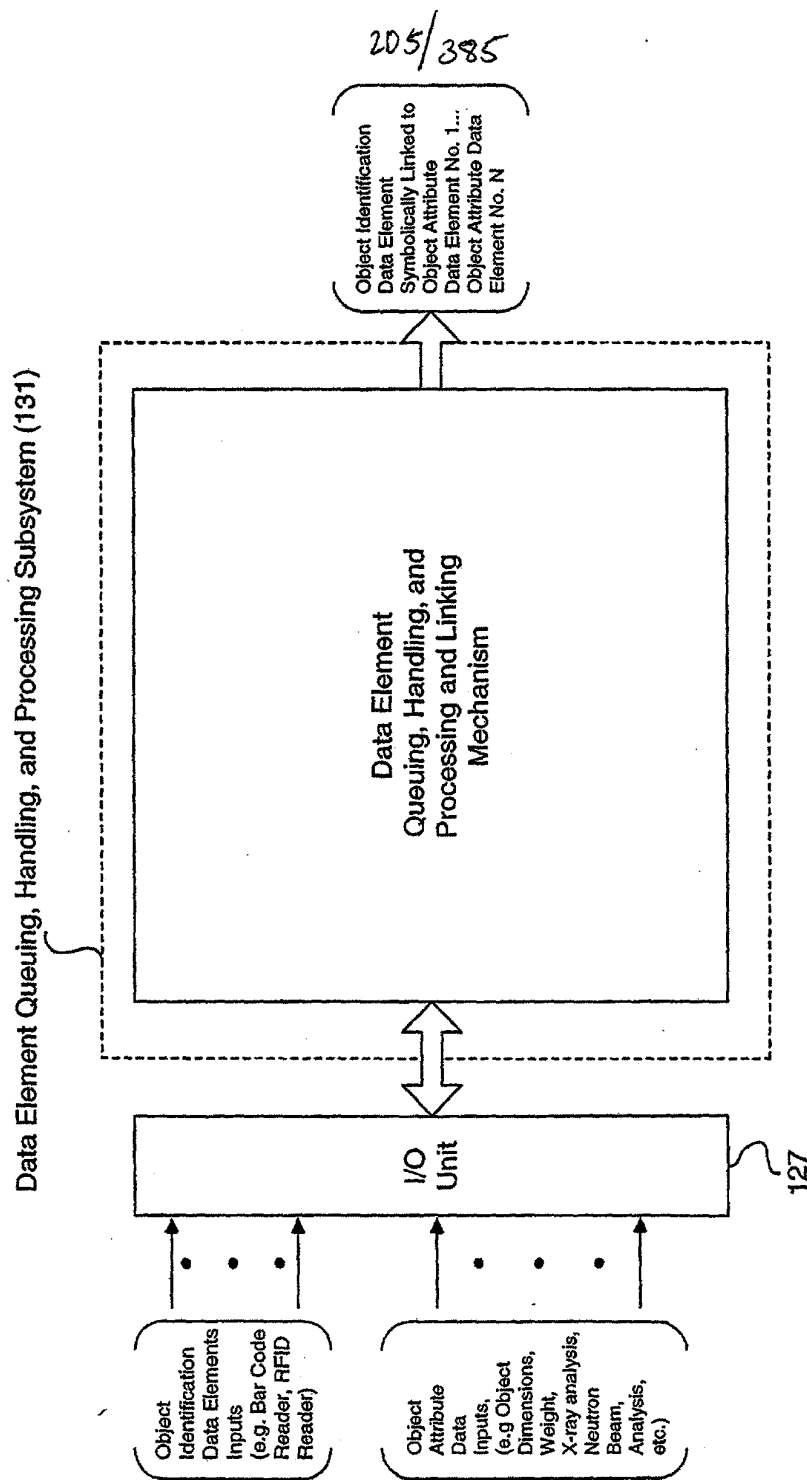


FIG. 10A

Primary Network  
and/ or System  
Functions:

A.  
Specification of Object  
Detection and  
Tracking Capability of  
System

B.  
Specification of Object  
Identification  
Capability of System

C.  
Specification of  
Object Attribute  
Acquisition Capability  
of System

Specification of Object Detection, Tracking, and Identification and  
Attribute-Acquisition Capabilities of a Configured System or Network.

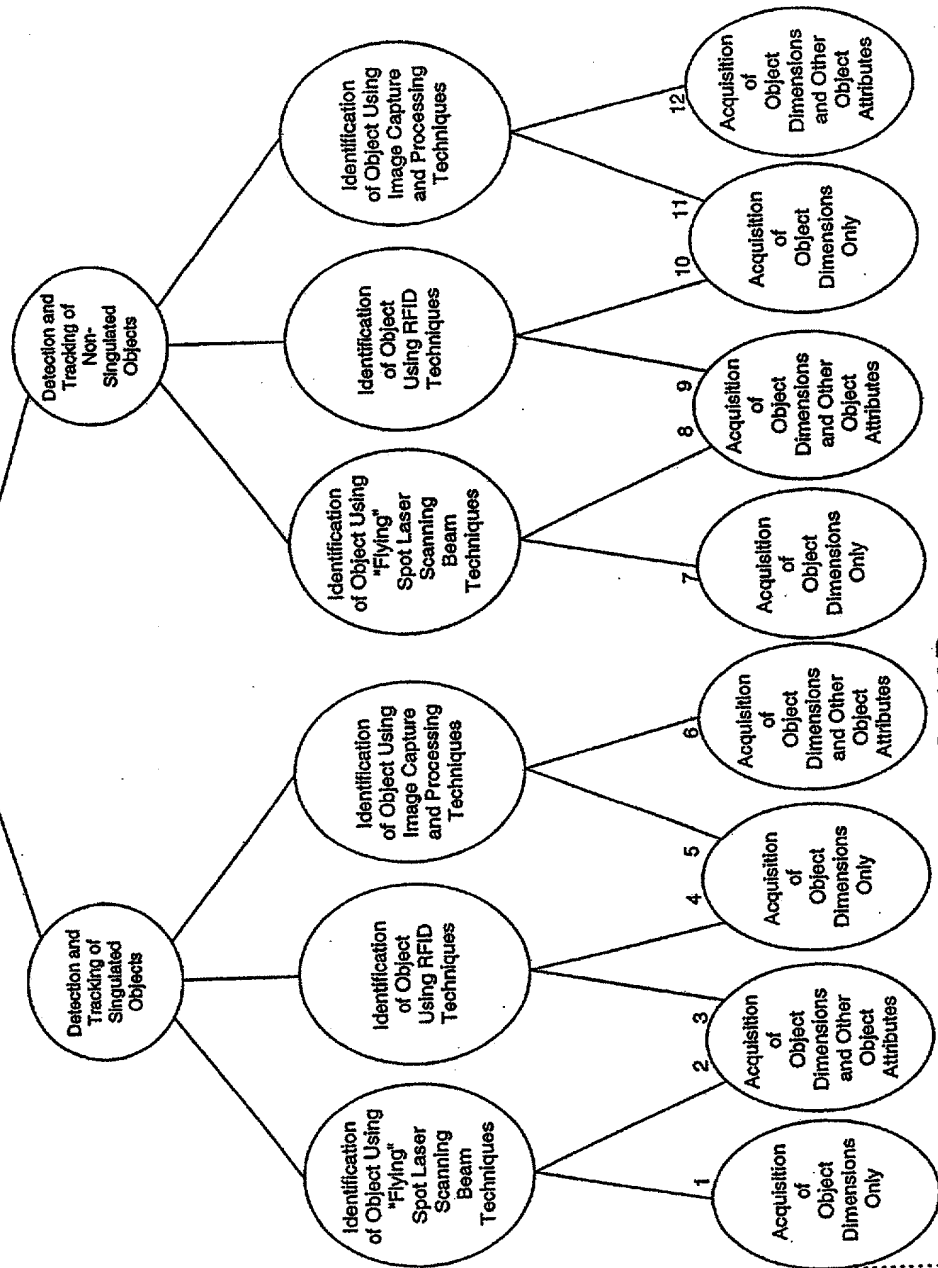


FIG. 10B

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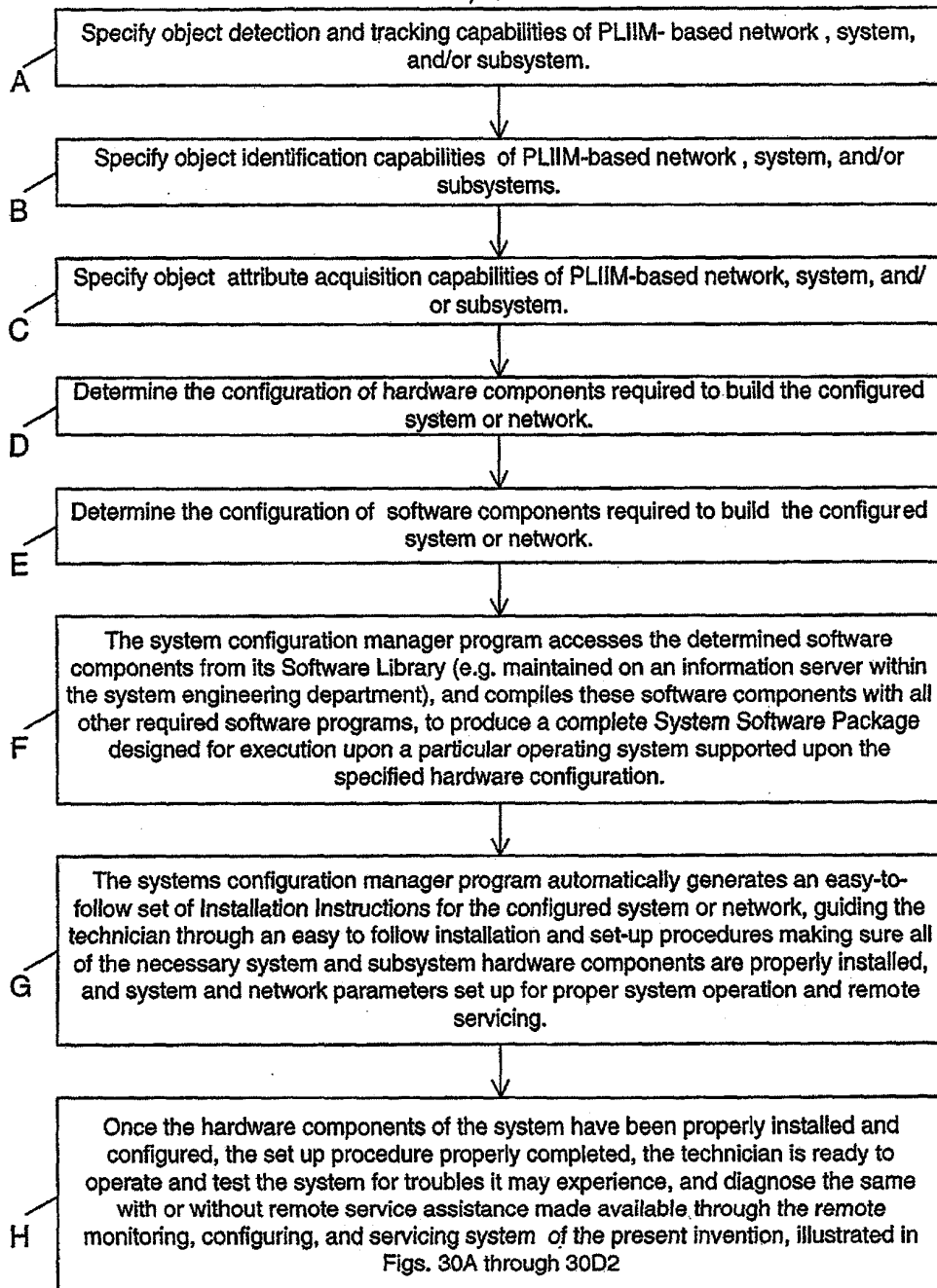
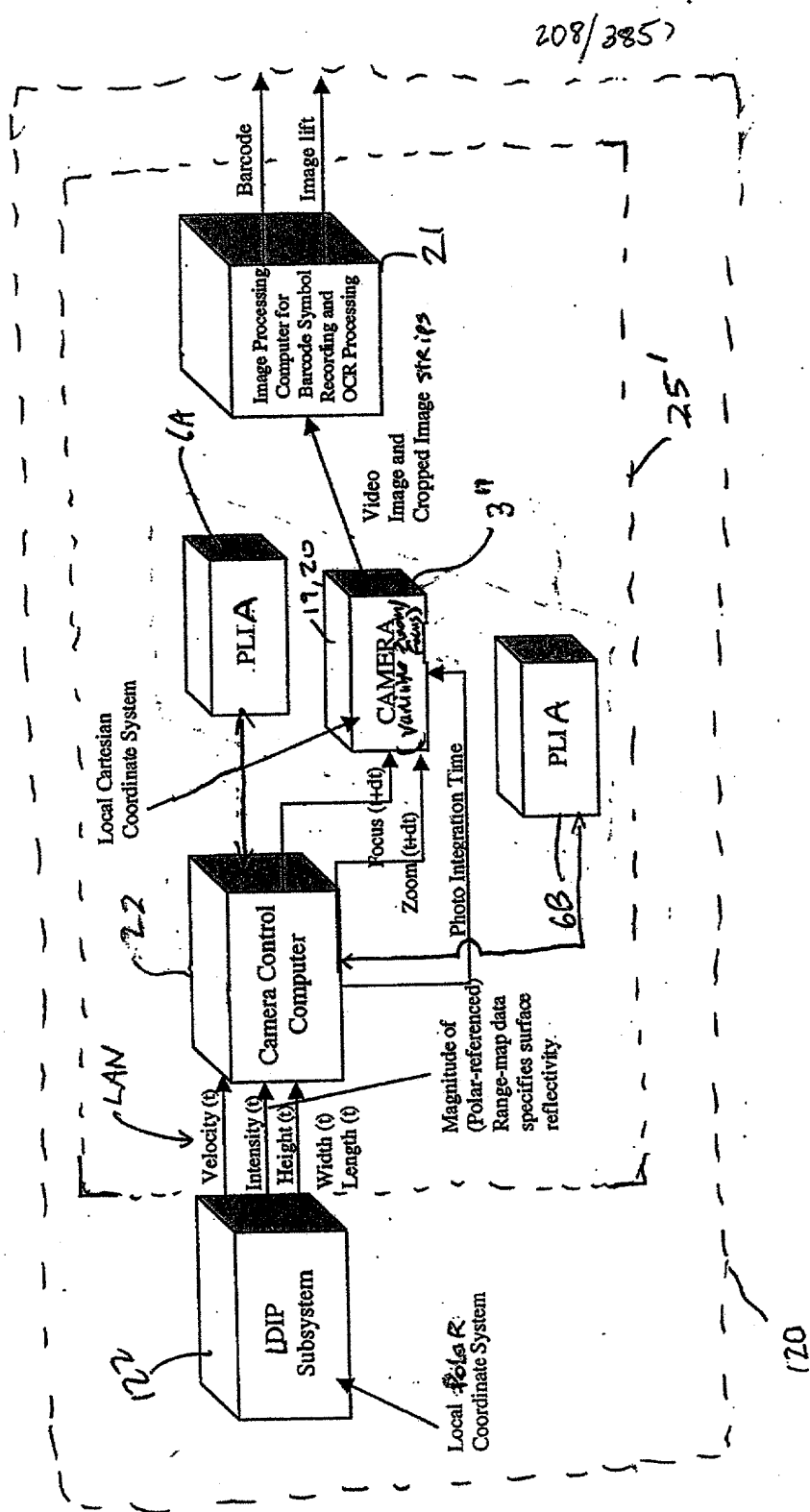


FIG. 10C



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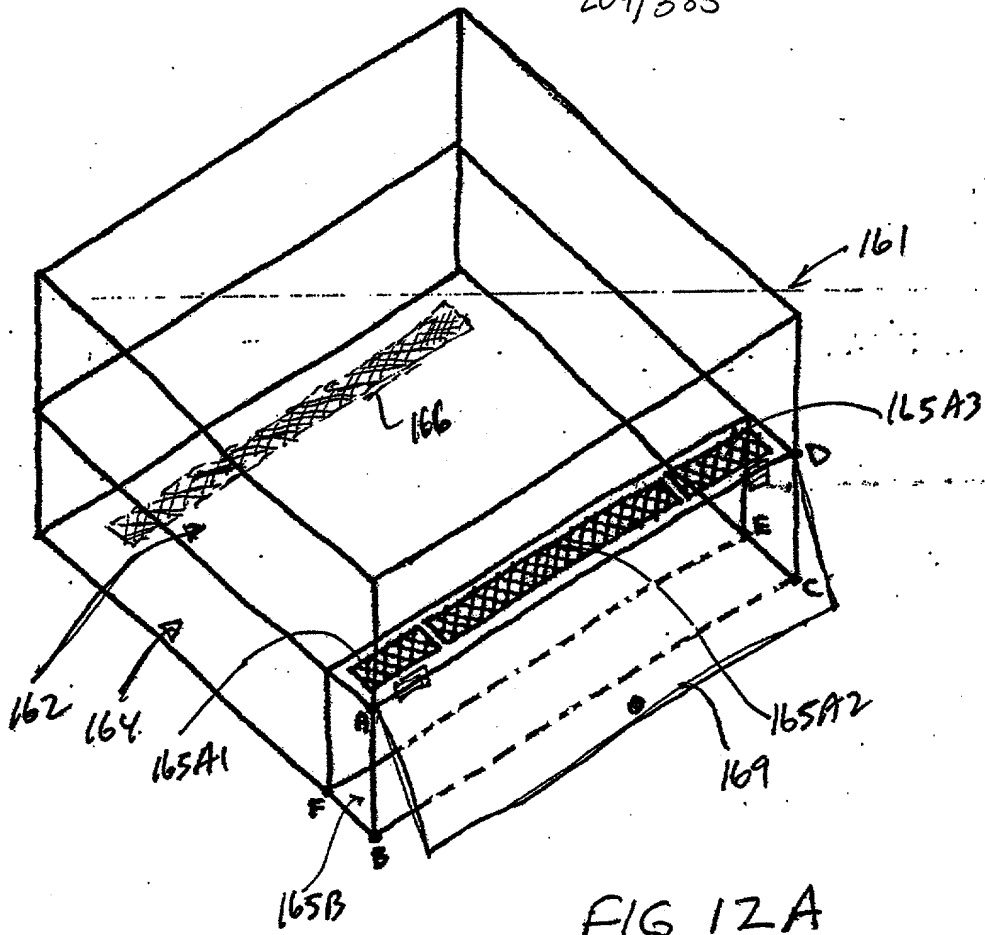


FIG. 12A

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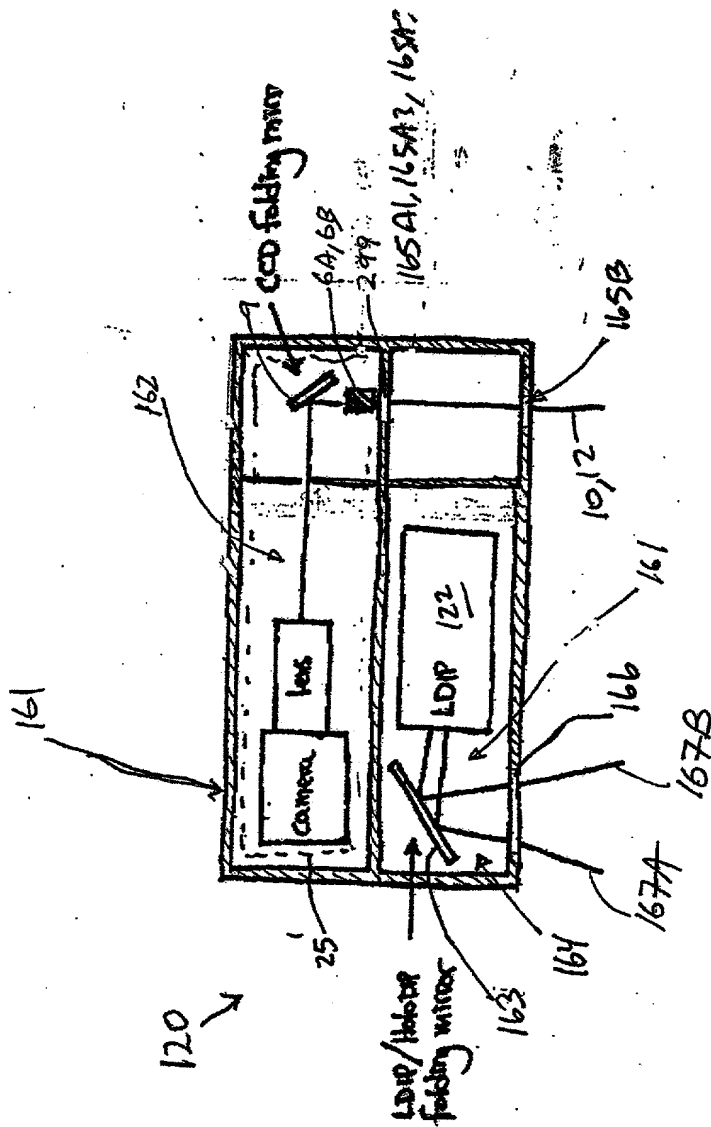


FIG. 12B

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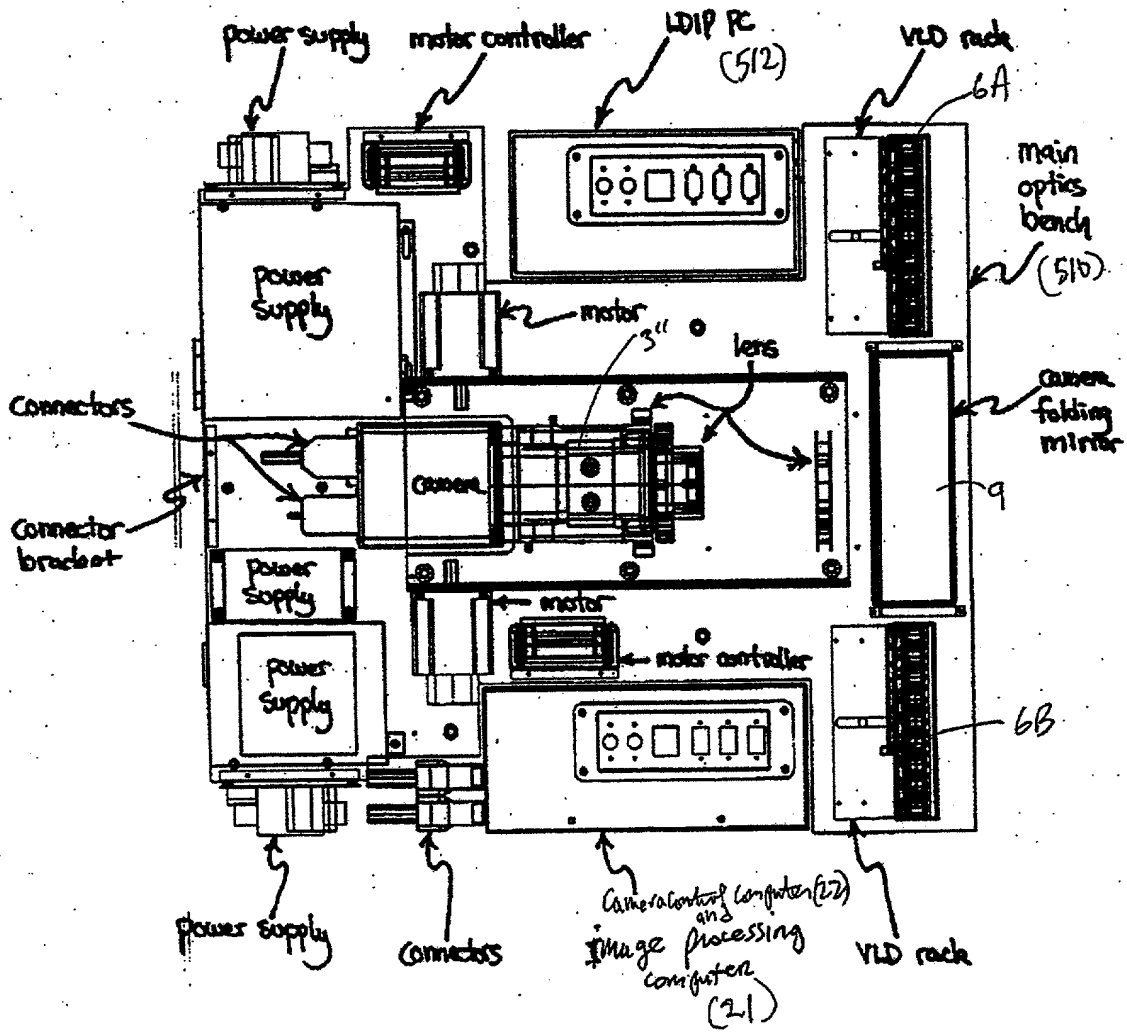


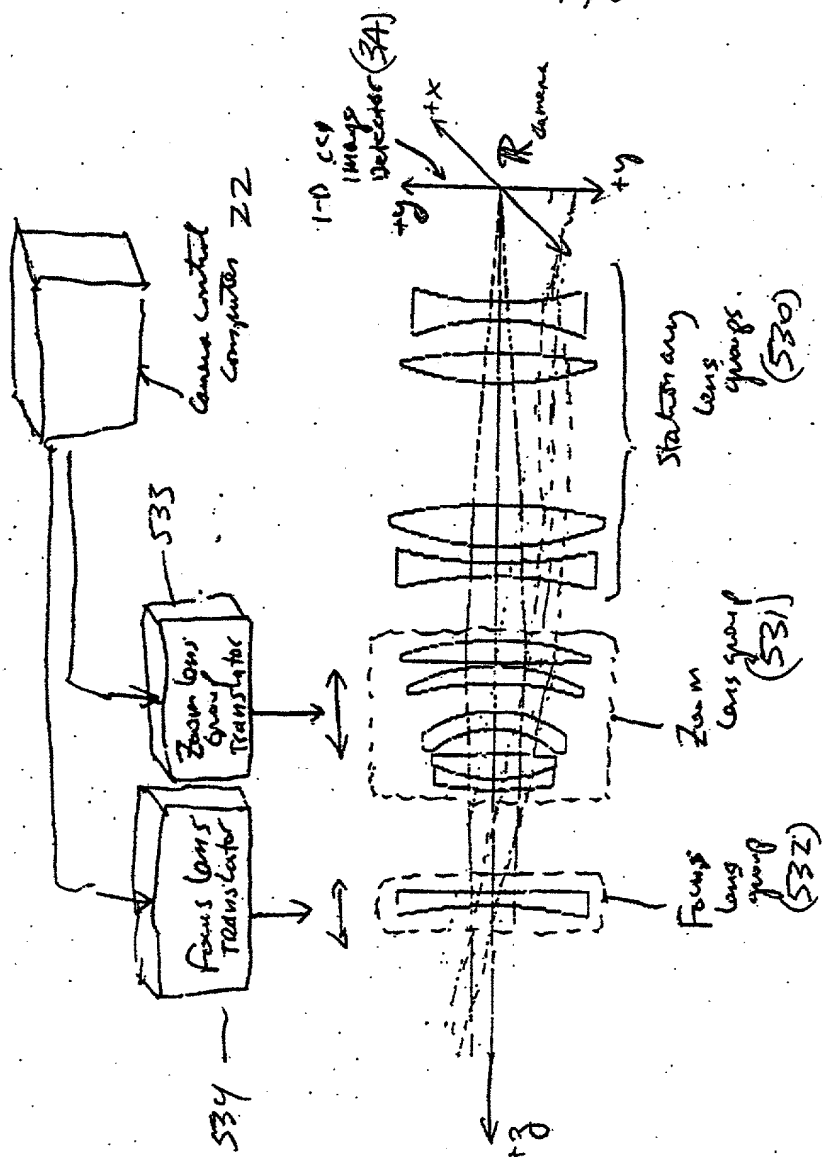
FIG. 12C

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(main optics)  
(Lens groups)

FIG. 12E

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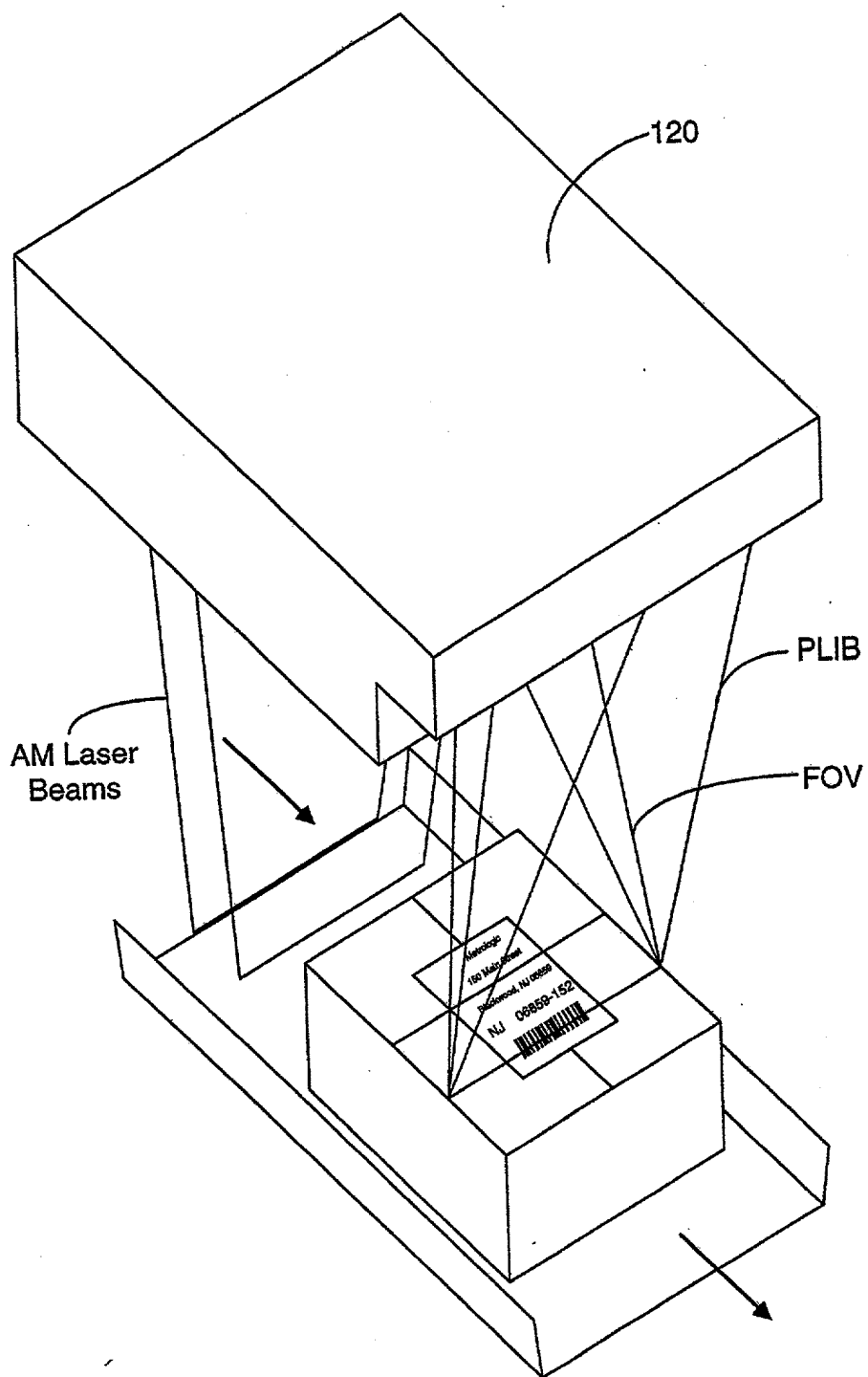


FIG. 13A

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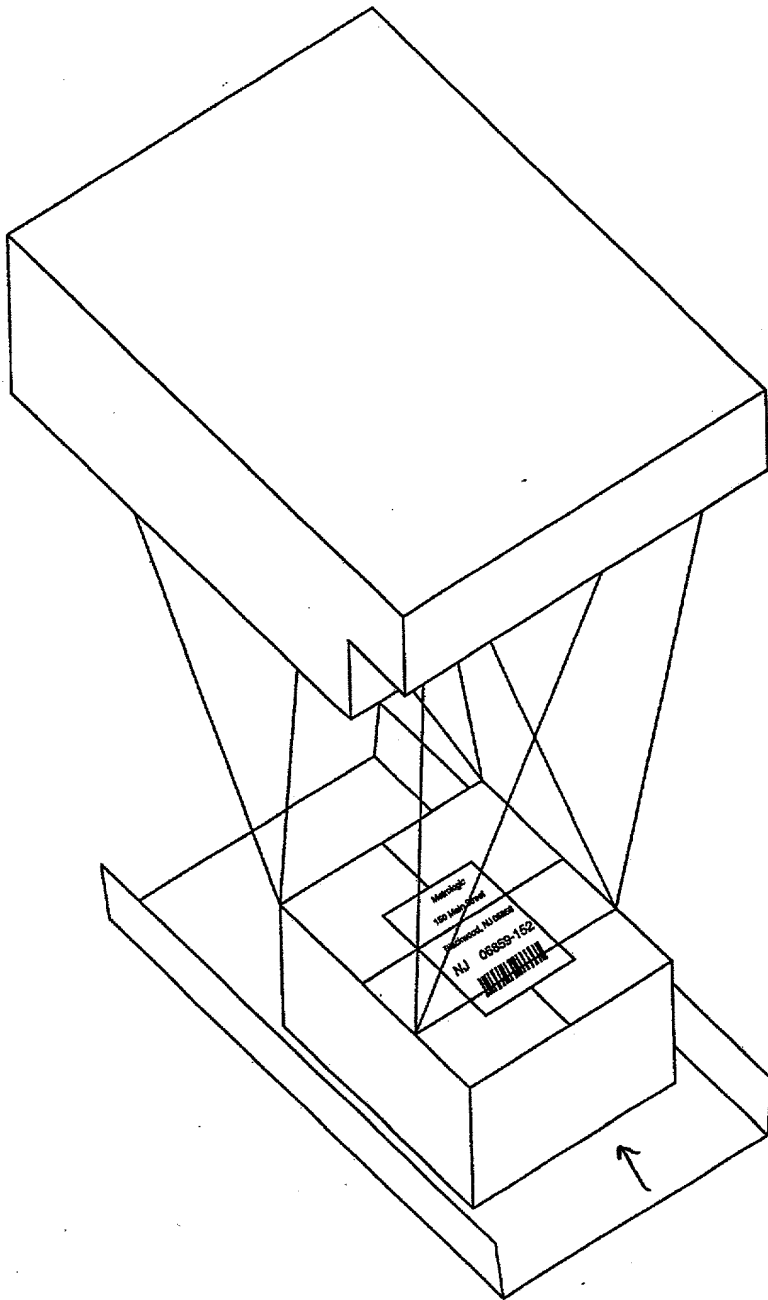


FIG. 13A

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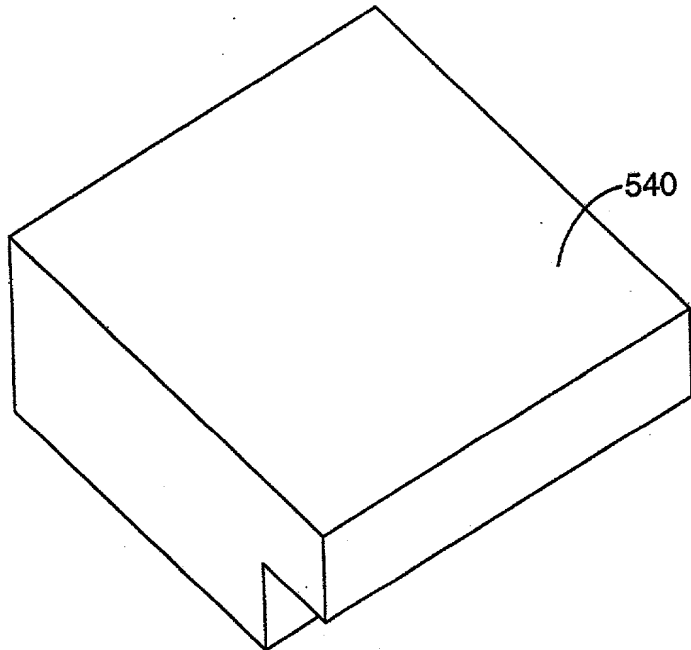


FIG. 13B

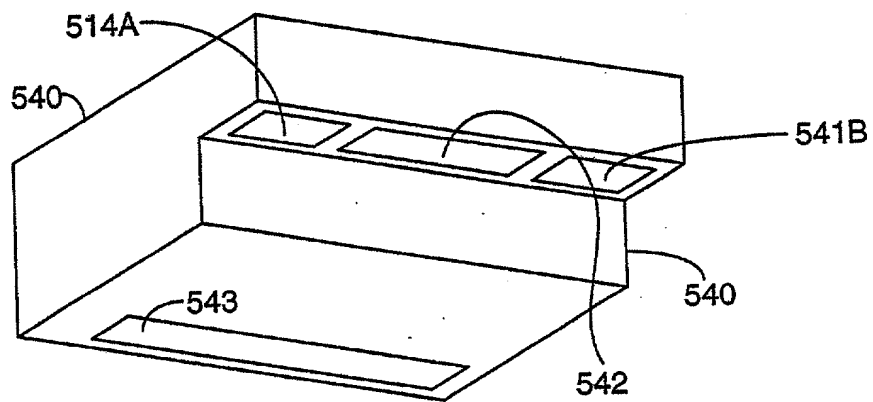


FIG. 13C

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 PLLIM-BASED PACKAGE IDENTIFICATION AND  
 DIMENSIONING (PID) SYSTEM

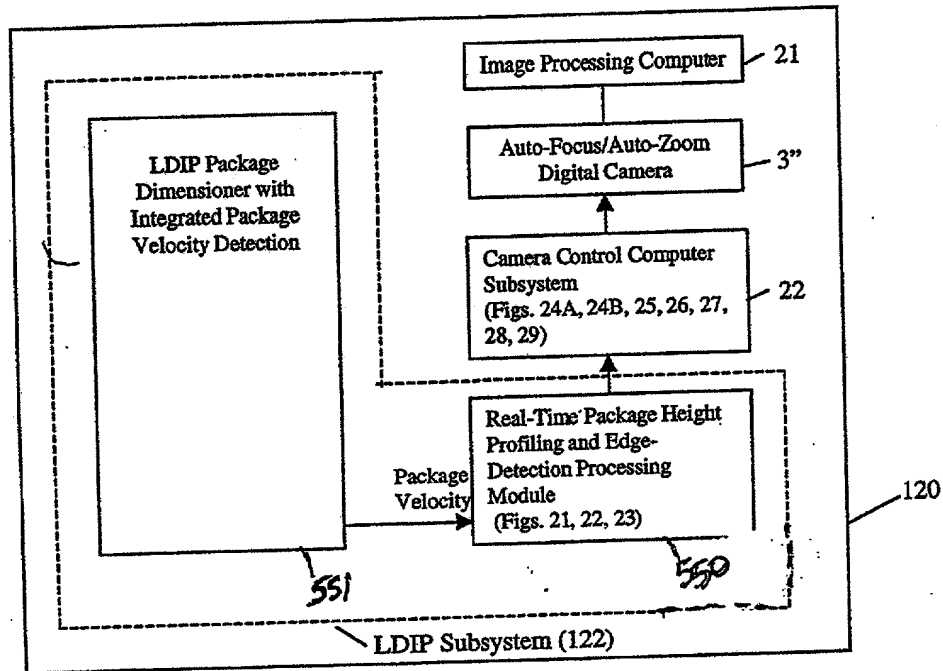


FIG. 14

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# LDIP REAL-TIME PACKAGE HEIGHT PROFILE AND EDGE DETECTION METHOD

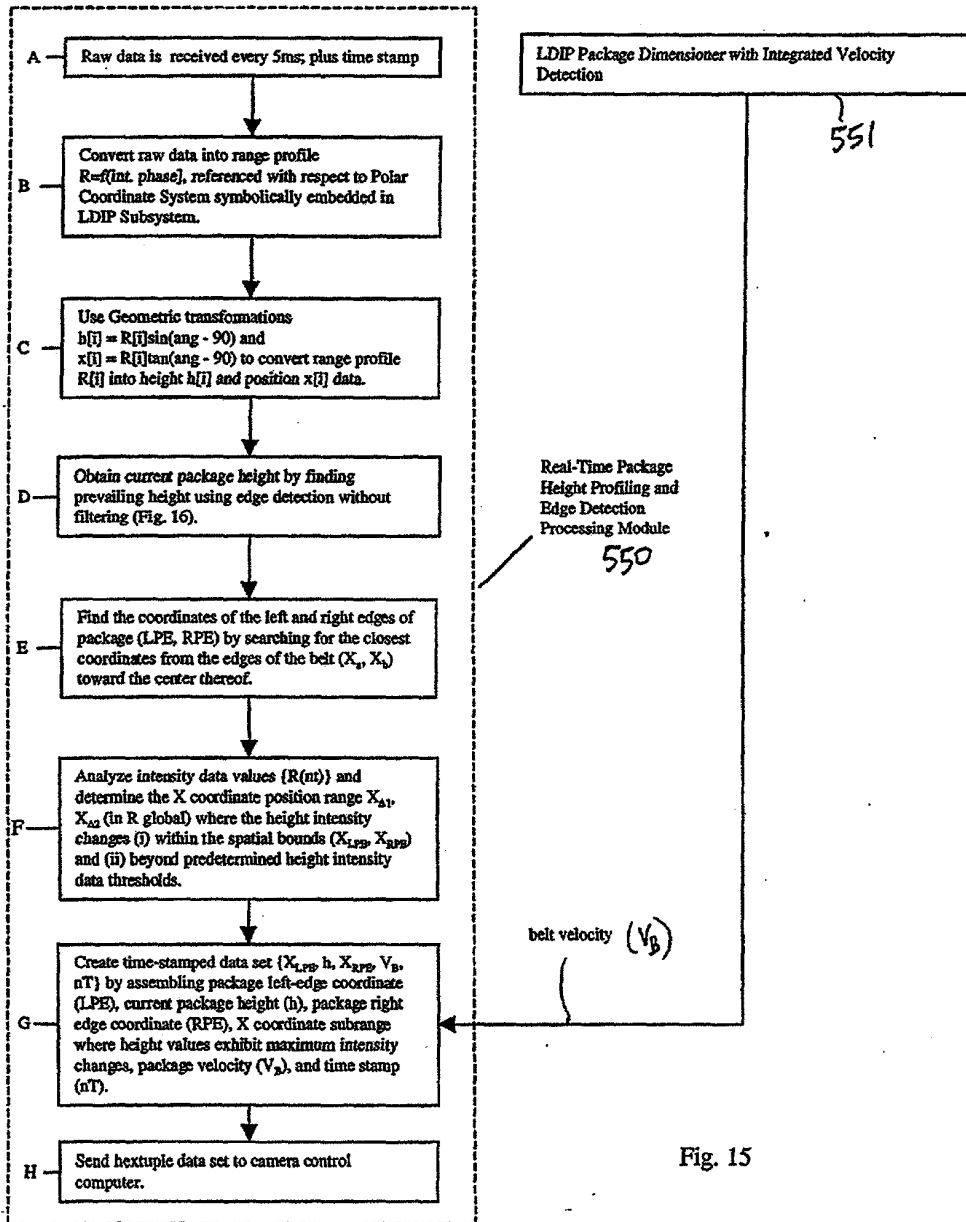
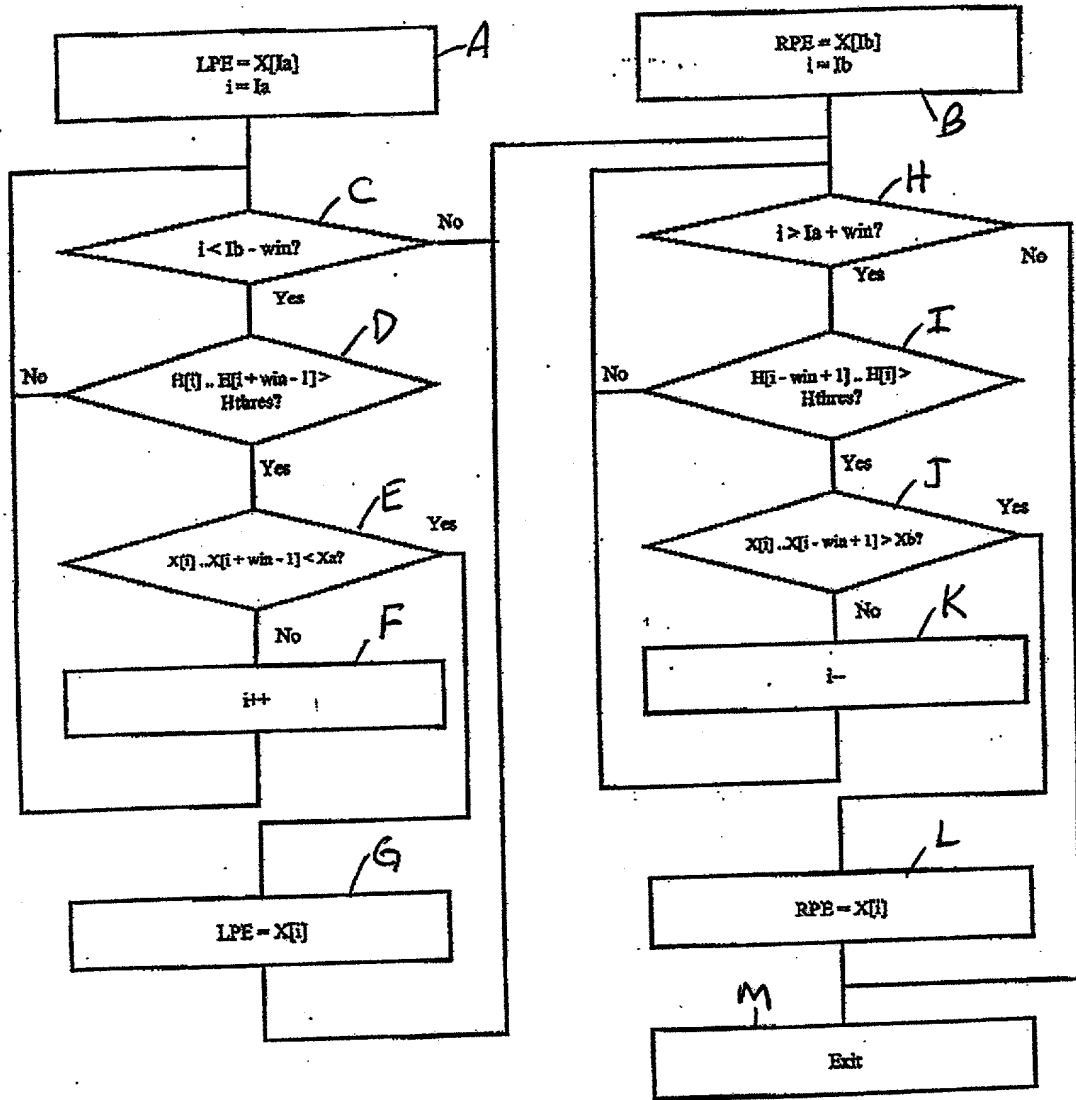


Fig. 15

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# LDIP Real Time Package Edge Detection



Xa = location of belt left edge; Xb = location of belt right edge  
 la = belt edge edge pixel; lb = belt right edge pixel  
 LPE = Left package edge; RPE = Right package edge  
 H[] = Pixel height array; X[] = Pixel location array  
 win = package detection window

FIG. 16

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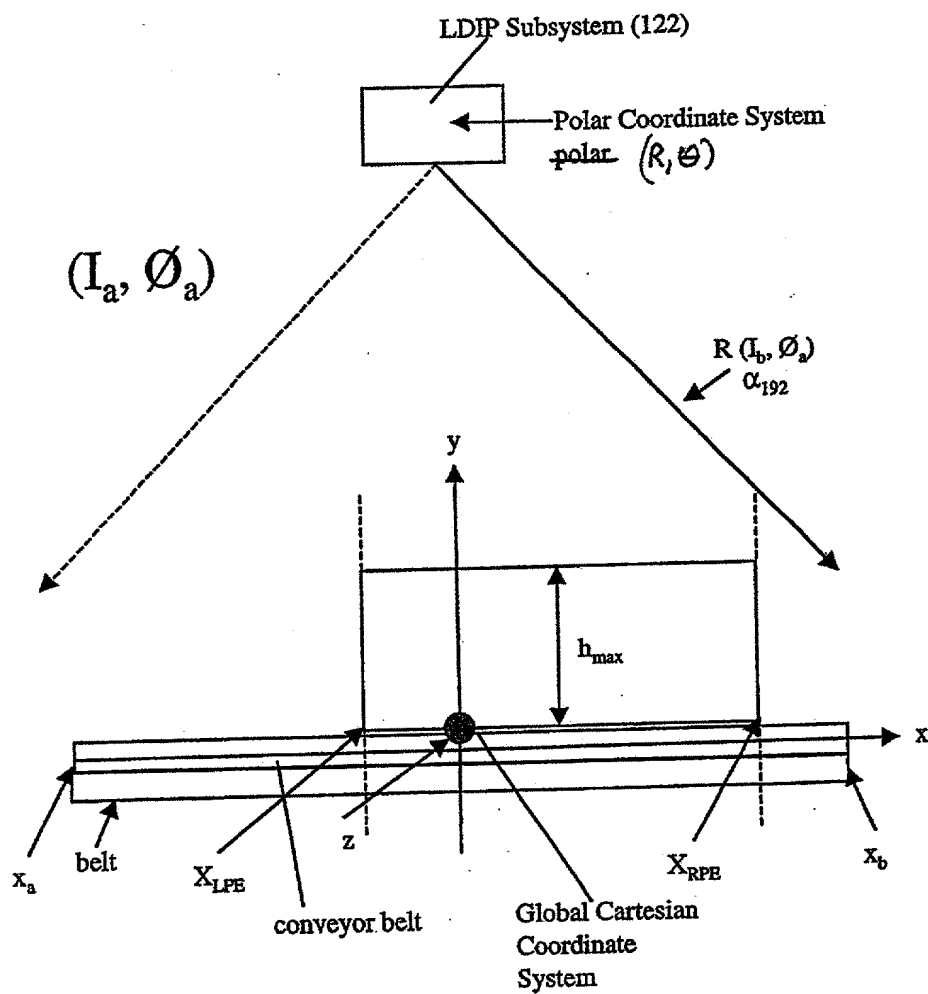


Fig. 17



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# INFORMATION MEASURED AT SCAN ANGLES BEFORE COORDINATE TRANSFORMS

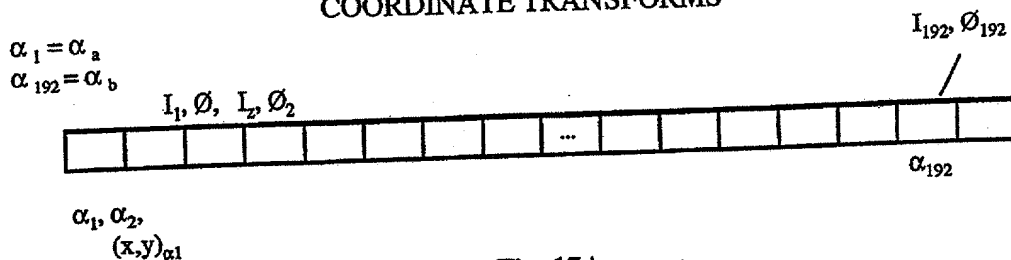


Fig. 17A

## RANGE AND POLAR ANGLE MEASURES TAKEN AT SCAN ANGLE $\alpha$ BEFORE COORDINATE TRANSFORMS

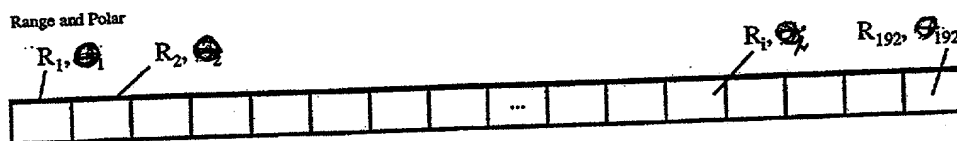


Fig. 17B

## MEASURED PACKAGE HEIGHT AND POSITION VALUES AFTER COORDINATE TRANSFORMS

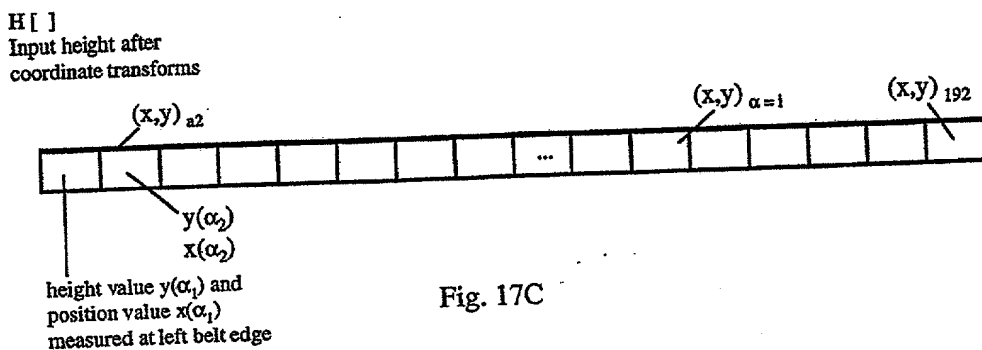


Fig. 17C

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CAMERA CONTROL PROCESS CARRIED OUT WITHIN THE CAMERA  
CONTROL SUBSYSTEM OF EACH OBJECT IDENTIFICATION AND  
ATTRIBUTE ACQUISITION SYSTEM OF PRESENT INVENTION

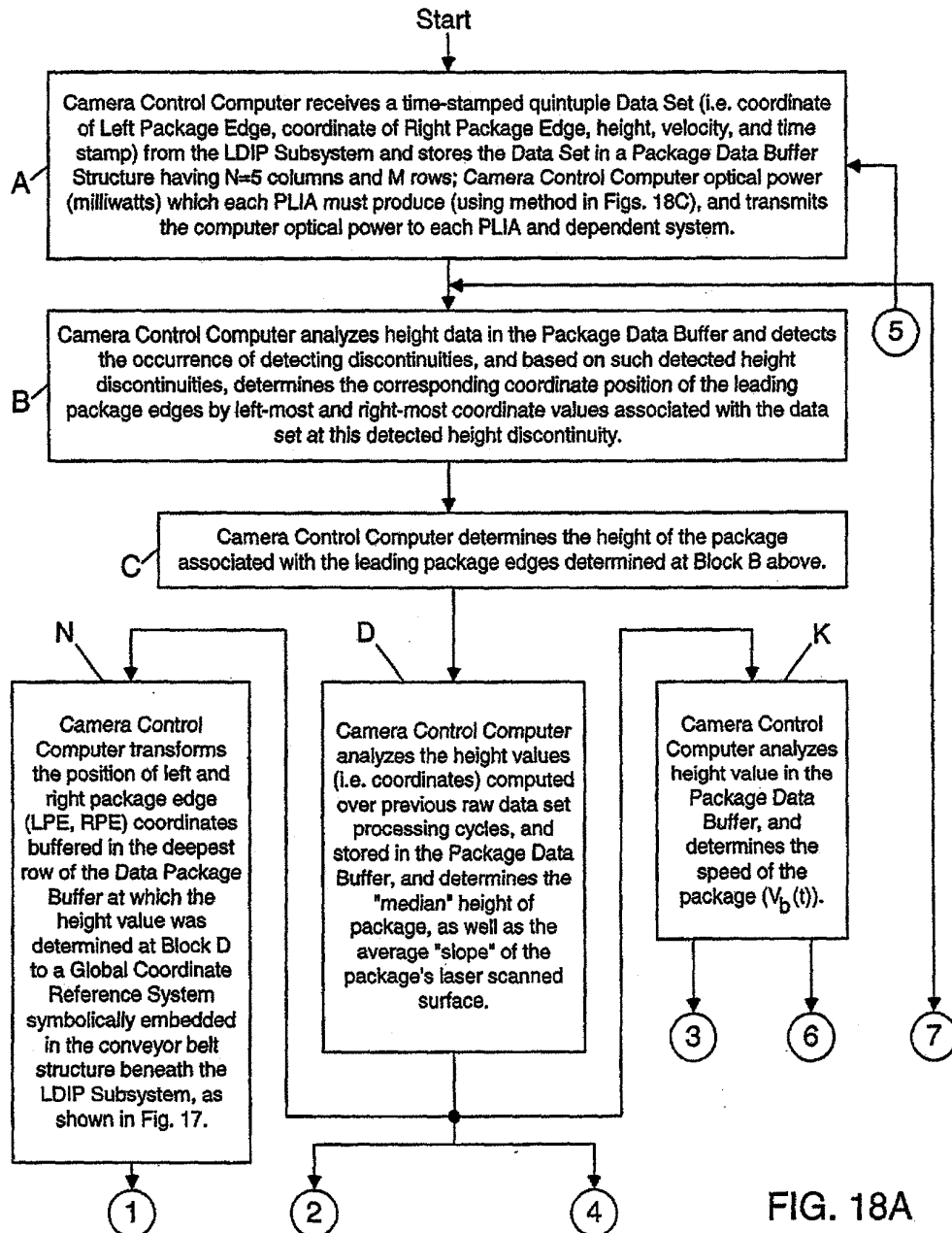


FIG. 18A

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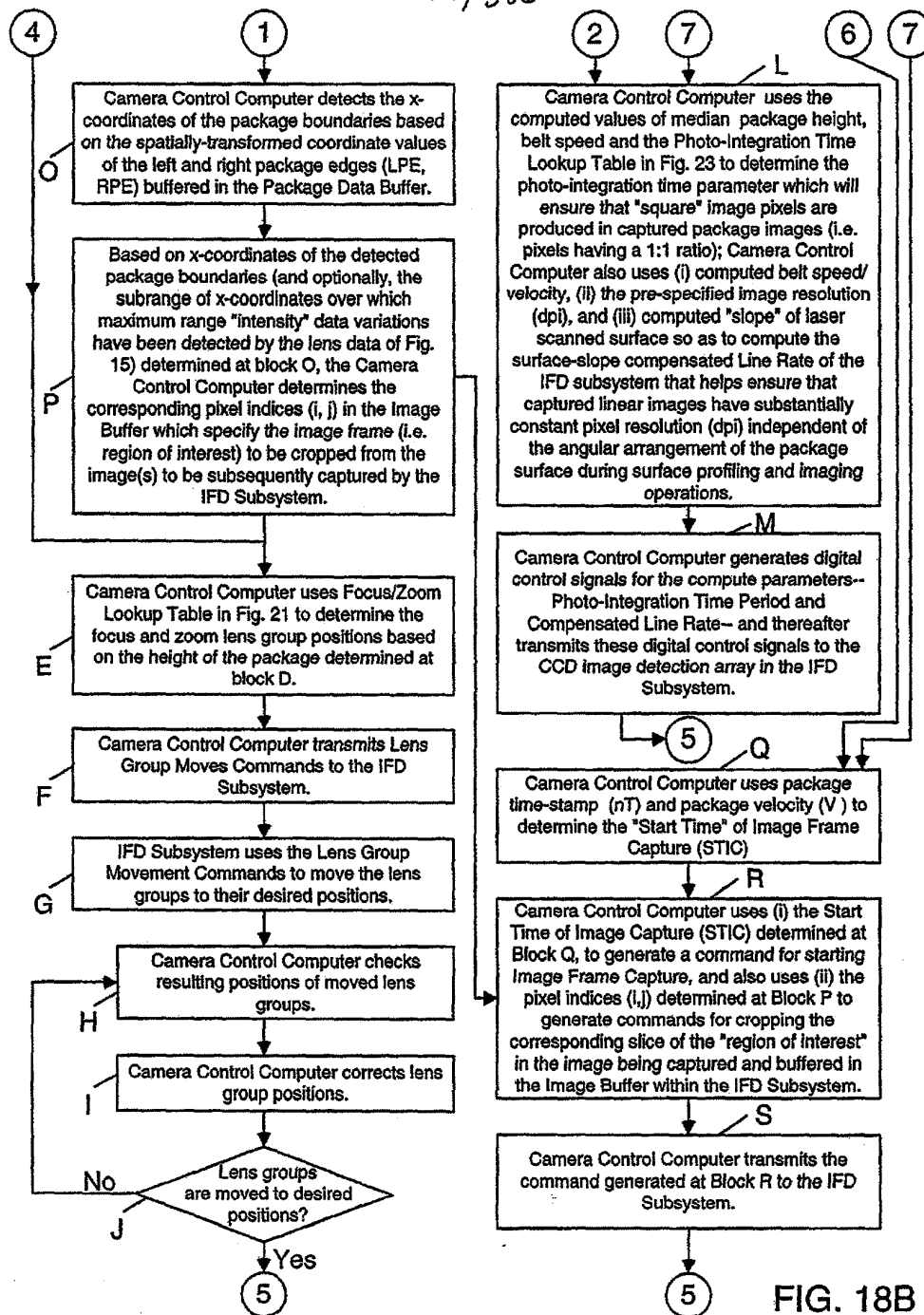


FIG. 18B

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METHOD OF COMPUTING OPTICAL OUTPUT POWER FROM CASE  
DIODES IN PLANAR LASER ILLUMINATION ARRAY (PLIA) FOR  
CONTROLLING CONSTANT WHITE LEVEL IN IMAGE PIXELS CAPTURED  
BY PLIIM-BASED LINEAR IMAGER

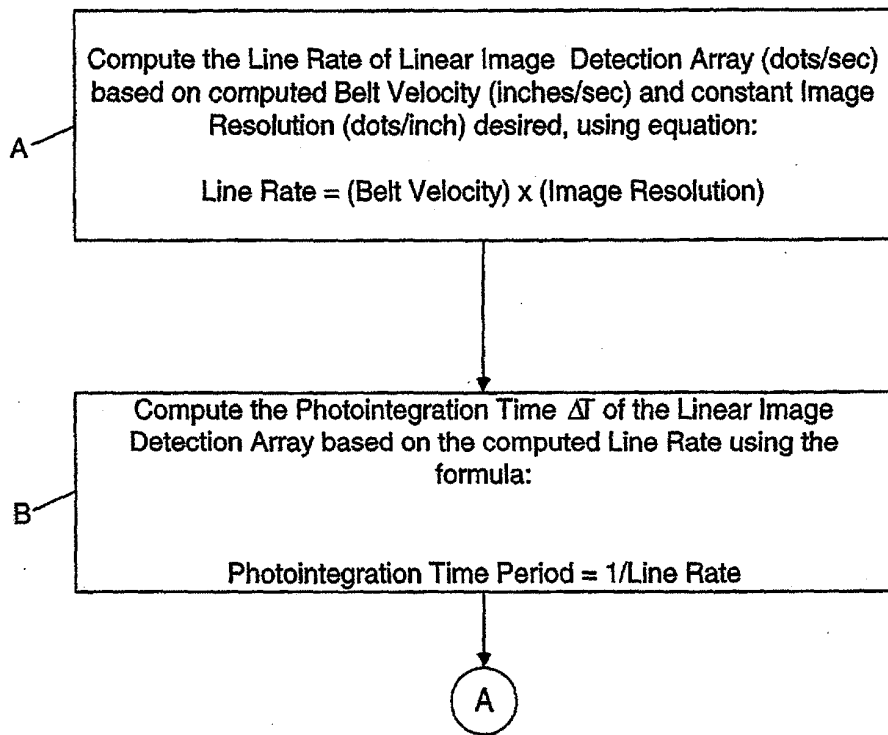


FIG. 18C1

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Compute the Optical Power (milliwatts) of each PLIA based on computed Photointegration Time Period ( $\Delta T$ ) using the following formula:

$$\text{Optical Power of VLD (milliwatts)} = \frac{\text{constant}}{\text{Photointegration Time Period } \Delta T}$$

FIG. 18C2

10060463-030703

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METHOD OF COMPUTING COMPENSATED LINE RATE FOR CORRECTING  
VIEWING-ANGLE DISTORTION OCCURING IN IMAGES OF OBJECT  
SURFACES CAPTURED AS OBJECT SURFACES MOVE PAST PLIIM-  
BASED LINEAR IMAGER AT NON-ZERO SKEWED ANGLE

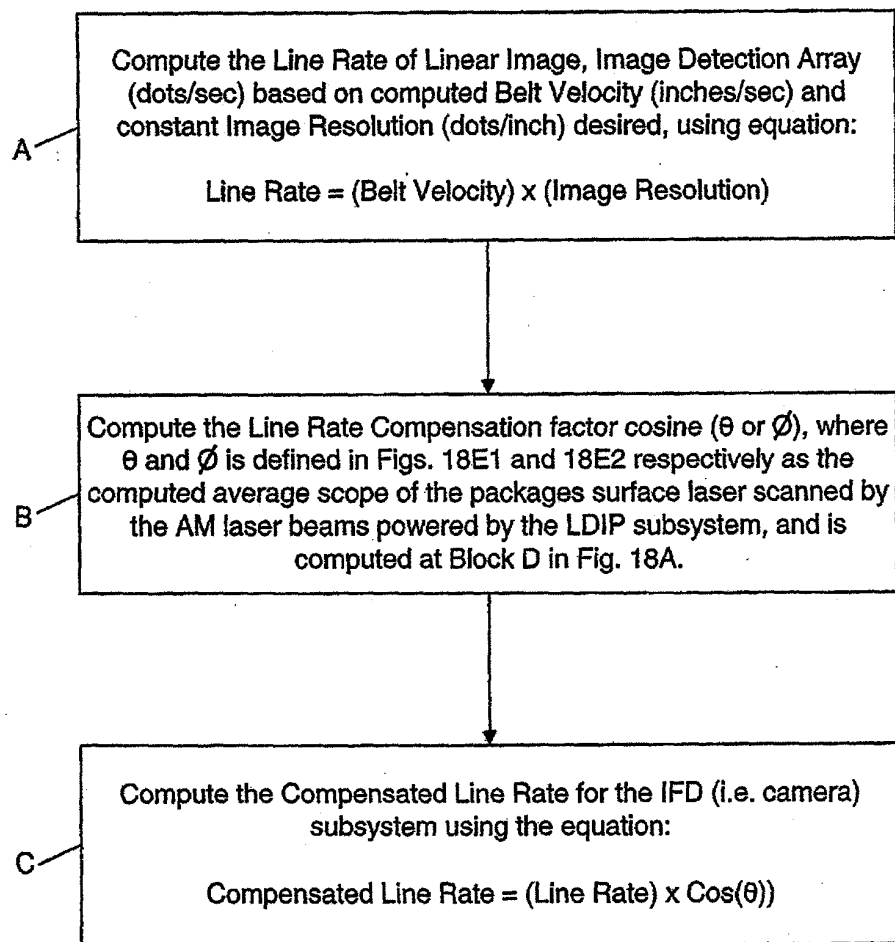


FIG. 18D

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CASE 1:  
Top Down Imaging

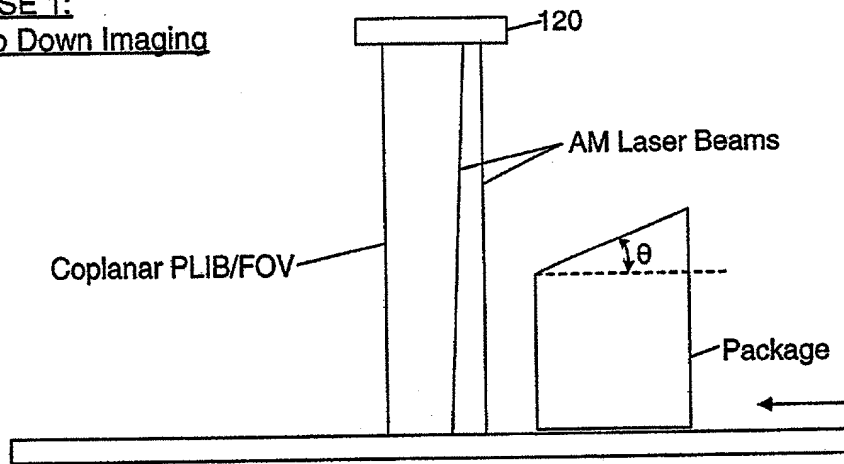


FIG. 18E1

CASE 2:  
Side Imaging

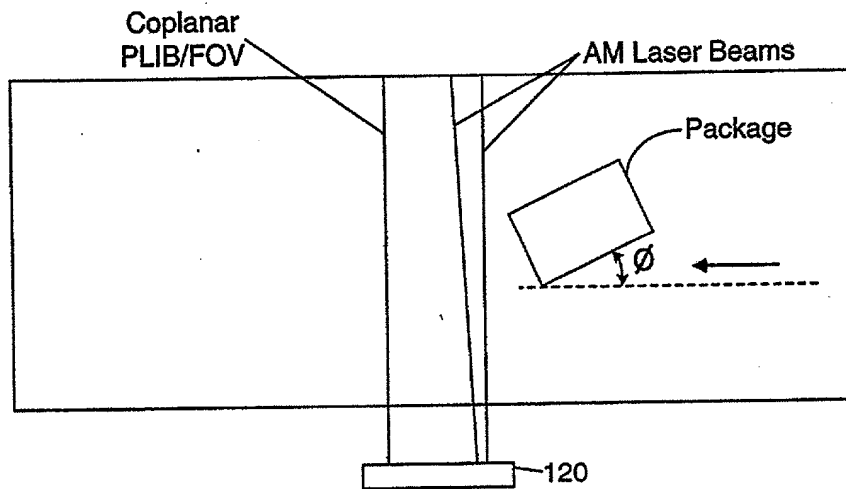


FIG. 18E2

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X coordinate subrange where  
maximum range "intensity"  
variations have been detected

Left Package Edge (LDE)	Package Height (h)	Right Package Edge (RPE)	Package Velocity	Time-stamp (nT)	
					Row 1
					Row 2
					Row 3
					Row 4
					Row 5
					Row M
Package Data Buffer (FIFO)					
Fig. 19					

																Columns	
																	Rows

Camera Pixel Data Buffer  
pixel indices (i,j)

Fig. 20

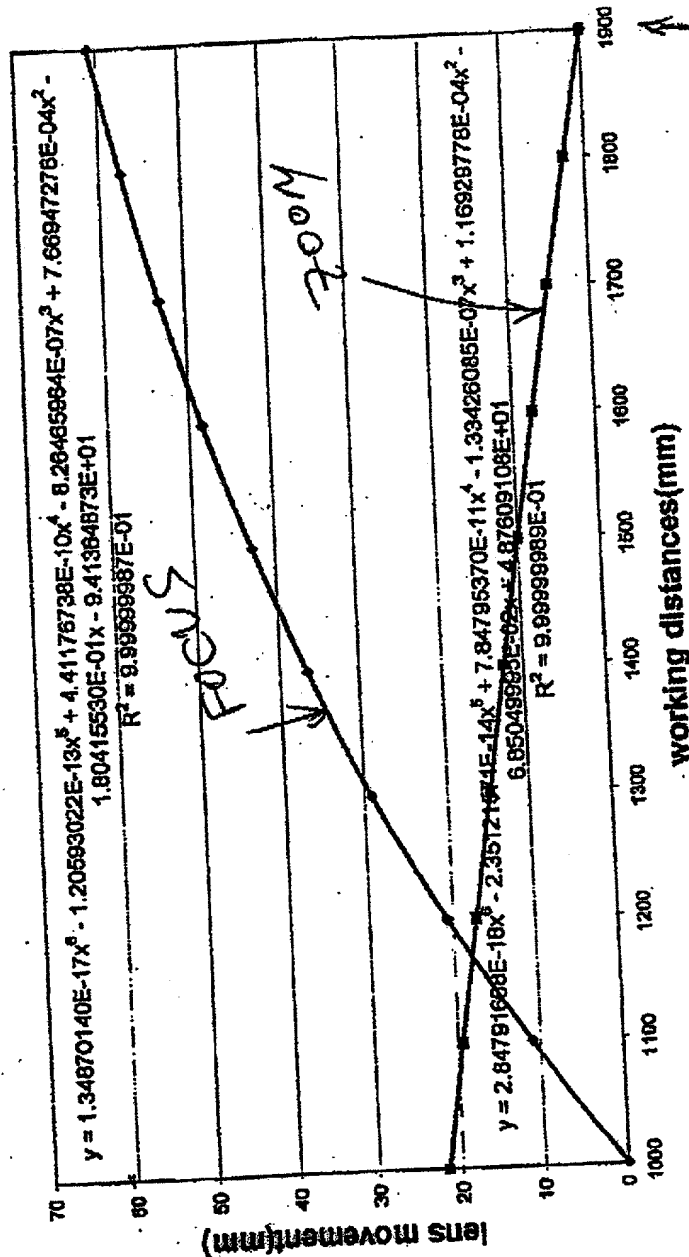




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\* Note: On feed distance & zoom (left feed length) in camera lens are coupled (interdependent) in camera has a fixed aperture F5.6  
 this camera is embedded

# Focus and Zoom lens movement vs. working distances



zoom 1 - zoom 2 - Poly. (zoom 1) - Poly. (zoom 2)

Conveyor-belt surface

← Package height above conveyor

30 above conveyor belt

FIG. 22A

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Photo-Integration Time Look-Up Table

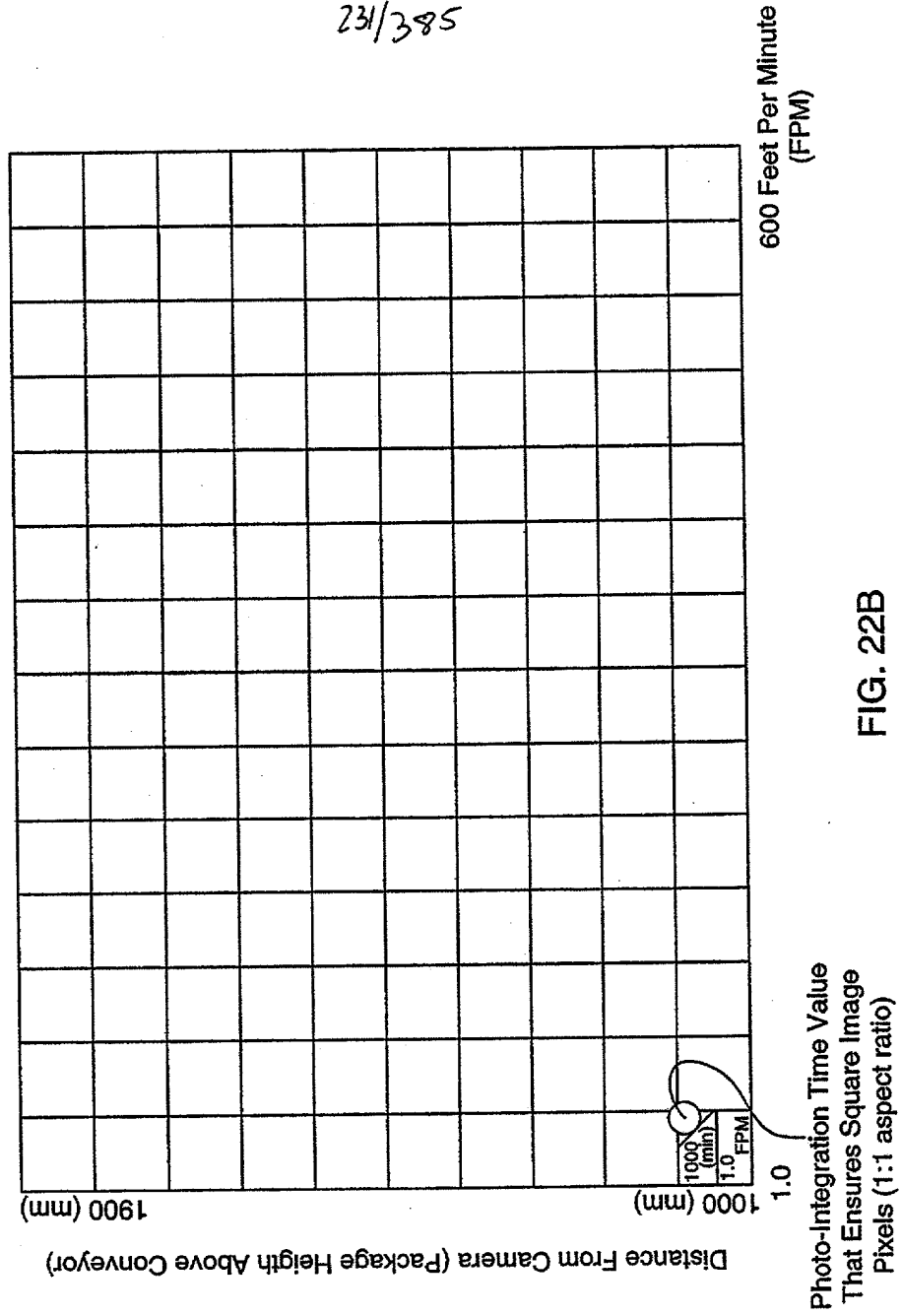


FIG. 22B

# 3D Surface Profile And High Resolution Linear Image Data Capture At PLIIM-Based Profiling And Imaging System

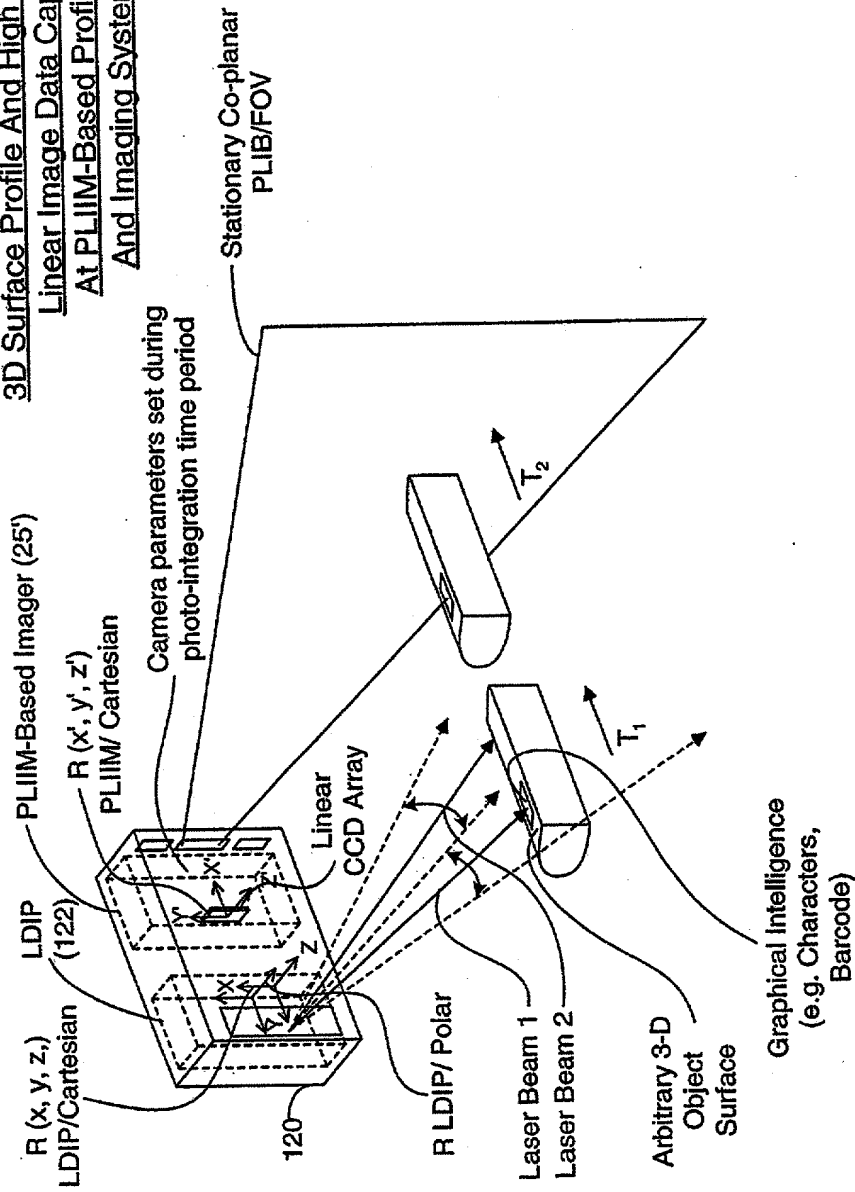


FIG. 23A

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# Geometrical Modelling Of Arbitrary 3-D Object Surface At Image Processing Computer

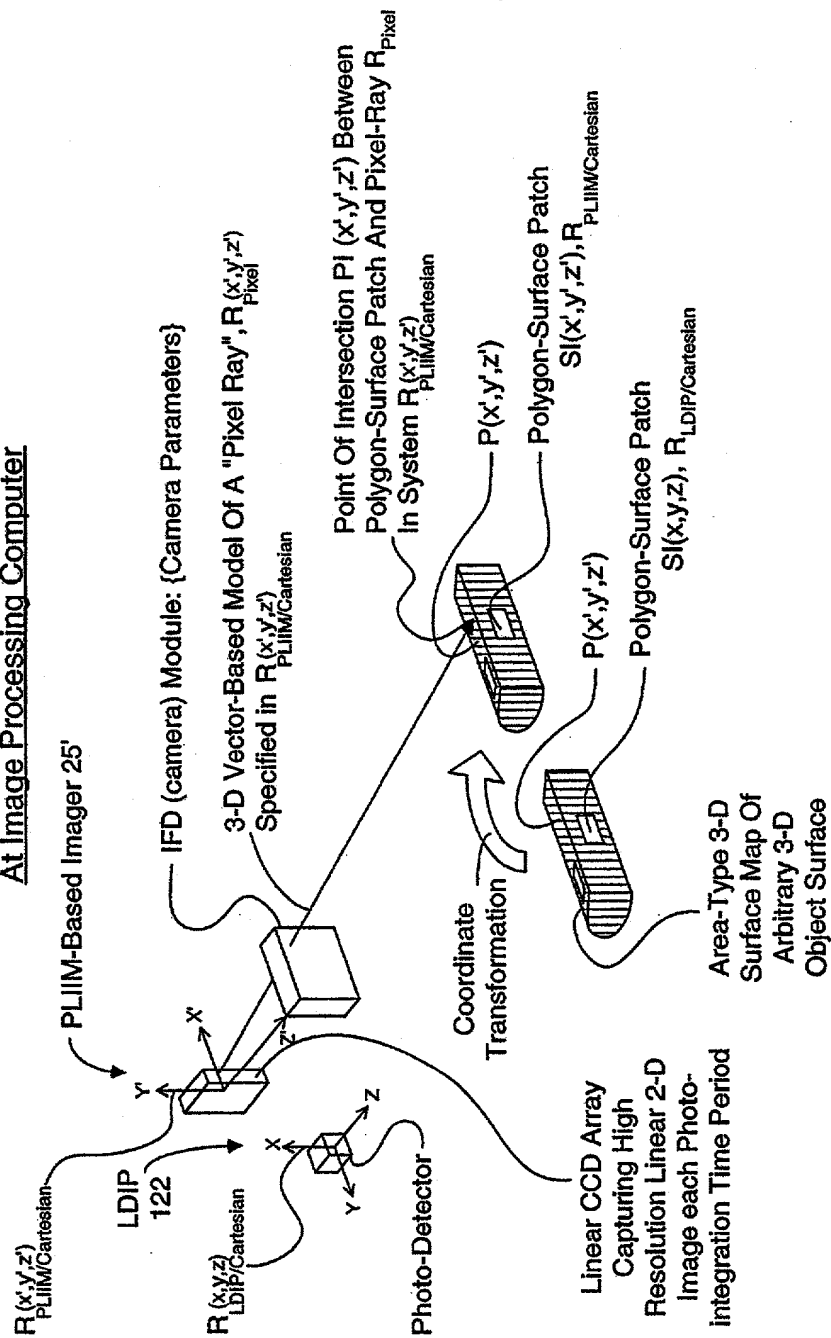


FIG. 23B

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METHOD OF AND APPARATUS FOR PERFORMING AUTOMATIC  
RECOGNITION OF GRAPHICAL INTELLIGENCE CONTAINED IN 2-D  
IMAGES CAPTURED FROM ARBITRARY 3-D OBJECT SURFACES

STEP 1: At the unitary PLIIM-based object imaging and profiling system, use the laser doppler imaging and profiling (LDIP) subsystem employed therein to (i) consecutively capture a series of linear 3-D surface profile maps on a targeted arbitrary (e.g. non-planar or planar) 3-D object surface bearing forms of graphical intelligence and (ii) measure the velocity of the arbitrary 3-D object surface, wherein the polar coordinates of each point in the captured linear 3-D surface profile map are specified in a local polar coordinate system  $R_{LDIP/polar}$ , symbolically embedded within the LDIP subsystem.

A

STEP 2: At the unitary PLIIM-based object imaging and profiling system, use coordinate transforms to automatically convert the polar coordinates of each point  $p(\alpha, R)$  in the captured linear 3-D surface profile map into  $x, y, z$  Cartesian coordinates specified as  $p(x, y, z)$  in a local Cartesian coordinate system  $R_{LDIP/Cartesian}$ , symbolically embedded within the LDIP subsystem.

B

STEP 3: At the unitary PLIIM-based object imaging and profiling system, use the PLIIM-based imager employed therein to consecutively capture high-resolution linear 2-D images of the arbitrary 3-D object surface bearing forms of graphical intelligence (e.g. symbol character strings), wherein (i) the  $x', y'$  coordinates of each pixel in each said captured high-resolution linear 2-D image is specified in local Cartesian coordinate system  $R_{PLIIM/Cartesian}$  symbolically embedded within the PLIIM-based imager, and (ii) the intensity value of the pixel  $I(x', y')$  is associated with the  $x', y'$  Cartesian coordinates of the image detection element in the linear image detection array at which the pixel is detected, and (iii) wherein also the planar laser illumination beam (PLIB) of the PLIIM-based imager is spaced from the amplitude modulated (AM) laser scanning beam of the LDIP subsystem is about D centimeters.

C

A

FIG. 23C1

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A

STEP 4: At the unitary PLIIM-based object imaging and profiling system, capture and buffer the camera (IFD) parameters used to form and detect each linear high-resolution 2-D image captured during the corresponding photo-integration time period  $\Delta T_K$ , by the PLIIM-based imager.

D

STEP 5: At the end of each photo-integration time period  $\Delta T_K$ , use the unitary PLIIM-based object imaging and profiling system to transmit the following information elements to the Image Processing Computer for data storage and subsequent information processing:

- (1) the converted coordinates  $x, y, z$ , of each point in the linear 3-D surface profile map of the arbitrary 3-D object surface captured during photo-integration time period  $\Delta T_K$ ;
- (2) the measured velocity(ies) of the arbitrary 3-D object surface during photo-integration time period  $\Delta T_K$ ;
- (3) the  $x', y'$  coordinates and intensity value  $I(x', y')$  of each pixel in each high-resolution linear 2-D image captured during photo-integration time period  $\Delta T_K$  and specified in the local Cartesian coordinate system  $R_{\text{PLIIM/Cartesian}}$ ; and
- (4) the captured camera (IFD) parameters used to form and detect each linear high-resolution 2-D image captured during the photo-integration time period  $\Delta T_K$

E

STEP 6: At the Image Processing Computer, receive the data elements transmitted from the PLIIM-based profiling and imaging system during Step 5, buffer data elements (1) and (2) in a first FIFO buffer memory structure, and data elements (3) and (4) in a second FIFO buffer memory structure.

F

B

FIG. 23C2

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(B)

STEP 7: At the Image Processing Computer, use the  $x, y, z$  coordinates associated with a consecutively captured series of linear 3-D surface profile maps (i.e. stored in first FIFO memory storage structure) in order to construct a 3-D polygon-mesh surface representation of said arbitrary 3-D object surface, represented by  $S_{LDIP}(x, y, z)$  and having (i) vertices specified by  $x, y, z$  in local coordinate reference system  $R_{PLIIM/Carthesian}$ , and (ii) planar polygon surface patches  $s_i(x, y, z)$  and being defined by a set of said vertices.

G

STEP 8: At the Image Processing Computer, convert the  $x', y', z'$  coordinates of each vertex in the 3-D polygon-mesh surface representation into the local Cartesian coordinate reference system  $R_{PLIIM/Carthesian}$  symbolically embedded within the PLIIM-based imager.

H

STEP 9: At the Image Processing Computer, specify the  $x', y', z'$  coordinates of each  $i$ -th planar polygon surface patch  $s(x, y, z)$  represented in the local Cartesian coordinate reference system  $R_{PLIIM/Carthesian}$ , so as to produce a set of corresponding polygon surface patch  $\{s_i(x', y', z')\}$  represented in system  $R_{PLIIM/Carthesian}$

I

STEP 10: At the Image Processing Computer, for a selected linear high-resolution 2-D image captured at photo-integration time period  $\Delta T_K$ , and spatially corresponding to one of the linear 3-D surface profile maps employed at Step 7, use the camera (IFD) parameters used and recorded (i.e. captured) during the corresponding photo-integration time period in order to construct a 3-D vector-based "pixel ray" model specifying the optical formation of each pixel in the linear 2-D image, wherein a pixel ray reflected off a point on the arbitrary 3-D object surface is focused through the camera's image formation optics (i.e. configured by the camera parameters) and is detected at the pixel's detection element in the linear image detection array of the IFD (camera) subsystem.

J

(C)

FIG. 23C3



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C

STEP 11: At the Image Processing Computer, for each laser beam ray (producing one of the pixels in said selected linear 2-D image), (i) determine which polygon surface patch  $s_i(x, y, z)$  the pixel ray intersects, (ii) compute the  $x, y, z$  coordinates of the point of intersection (POI) between the pixel ray and the polygon surface patch represented in Cartesian coordinate reference system  $R_{PLIIM/Cartesian}$ , and (iii) designate the computed set of points of intersection as  $\{p_i(x, y, z)\}$ .

K

STEP 12: At the Image Processing Computer, for each laser beam ray passing through a determined polygon surface patch  $s(x', y', z')$  at a computed point of intersection  $p_i(x, y, z)$ , assign the intensity value  $I(x', y')$  of the pixel ray to the  $x', y', z'$  coordinates of the point of intersection, thereby producing a linear high-resolution 3-D image comprising a 2-D array of pixels, each said pixel pixel having as its attributes (i) an Intensity value  $I(x', y', z')$  and (ii) coordinates  $x', y', z'$  specified in the local Cartesian coordinate reference system  $R_{PLIIM/Cartesian}$ .

L

STEP 13: Put the computed linear high-resolution 3-D image in a third FIFO memory storage structure in the image processing computer.

M

STEP 14: Repeat Steps 1-6 to update the first and second FIFO data queues maintained in the image processing computer, and Steps 7-13 to update the consecutively computed linear high-resolution 3-D image stored in the third FIFO memory storage structure.

N

STEP 15: Assemble in an image buffer in the image processing computer, a set of consecutively computed linear high-resolution 3-D images retrieved from the third FIFO data storage device so as to construct an "area-type" high-resolution 3-D image of said arbitrary 3-D object surface.

O

D

FIG. 23C4

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(D)

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STEP 16: At the Image Processing Computer, map the intensity value  $I(x', y', z')$  of each pixel in the computed area-type 3-D image onto the  $x', y', z'$  coordinates of the points on a uniformly-spaced apart "grid" positioned perpendicular to the optical axis of the camera subsystem (i.e. to model the 2-D planar substrate on which the forms of graphical intelligence was originally rendered), wherein said mapping process involves using an intensity weighing function based on the  $x', y', z'$  coordinate values of each pixel in the area-type high-resolution 3-D image, thereby producing an area-type high-resolution 2-D image of the 2-D planar substrate surface bearing said forms of graphical intelligence (e.g. symbol character strings).

P

STEP 17: At the Image Processing Computer, use said OCR algorithm to perform automated recognition of graphical intelligence contained in said area-type high-resolution 2-D image of said 2-D planar substrate surface so as to recognize said graphical intelligence and generate symbolic knowledge structures representative thereof.

Q

STEP 18: Repeat Steps 1-17 as often as required to recognize changes in graphical intelligence on the arbitrary moving 3-D object surface.

R

FIG. 23C5

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Photo-Integration Time Look-up Table

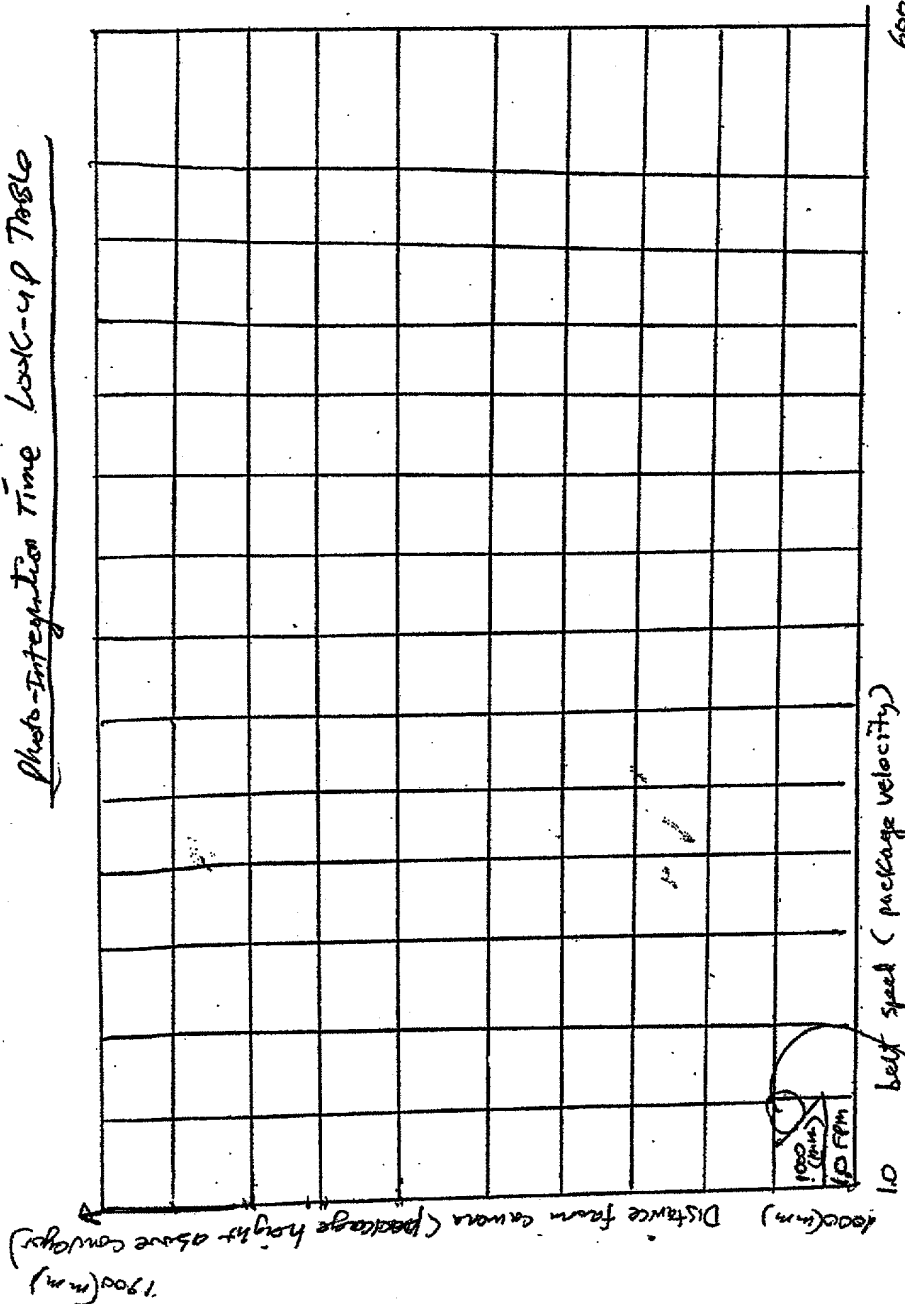


FIG. 22B

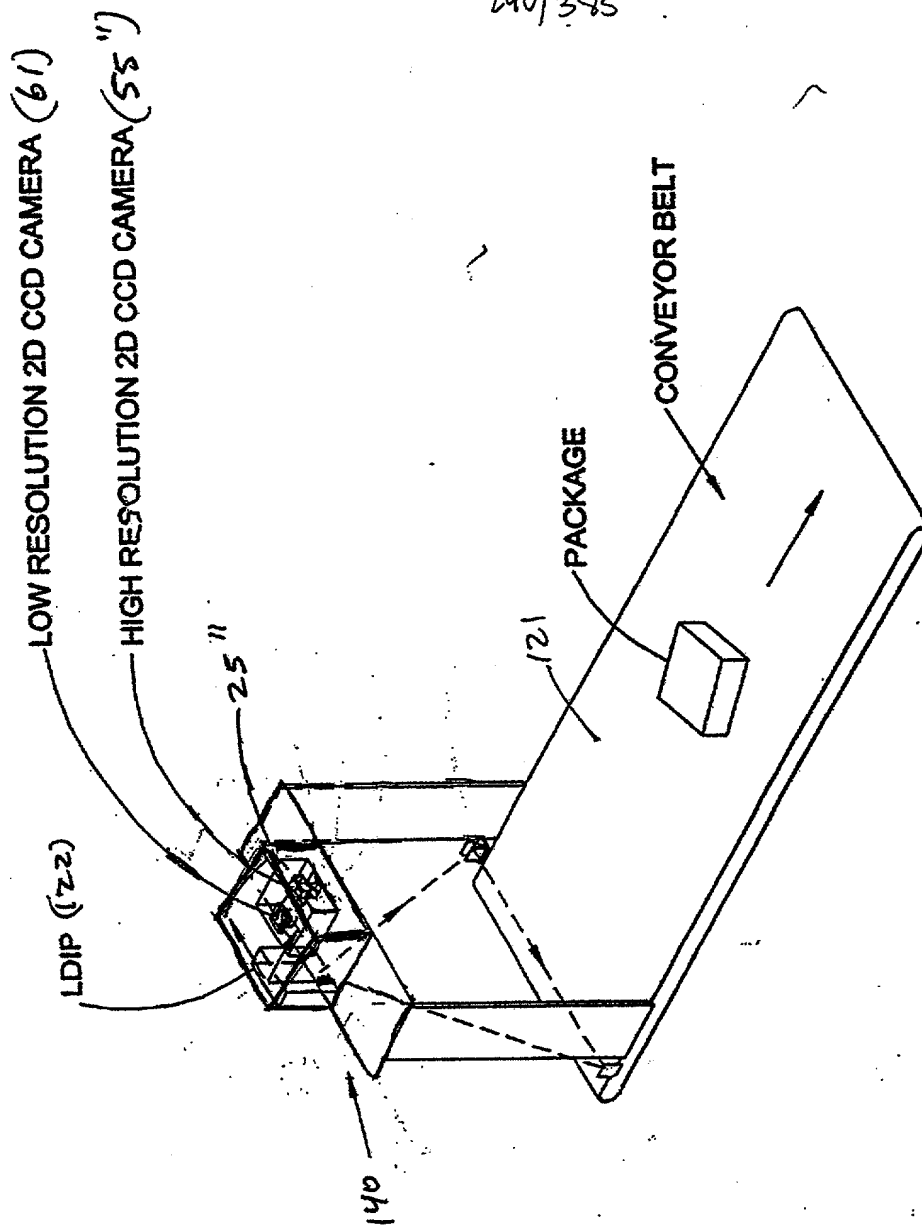
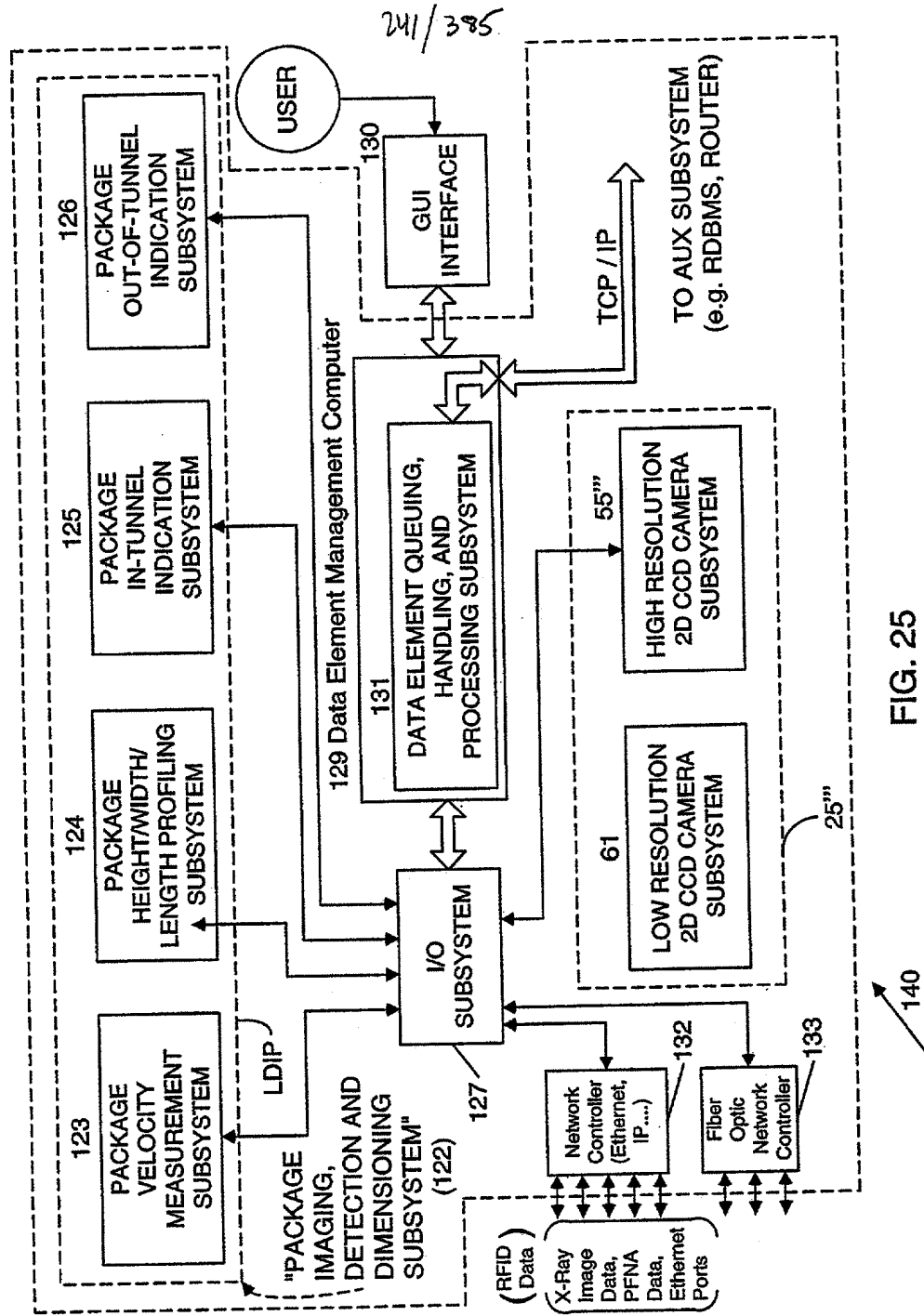


FIG 24



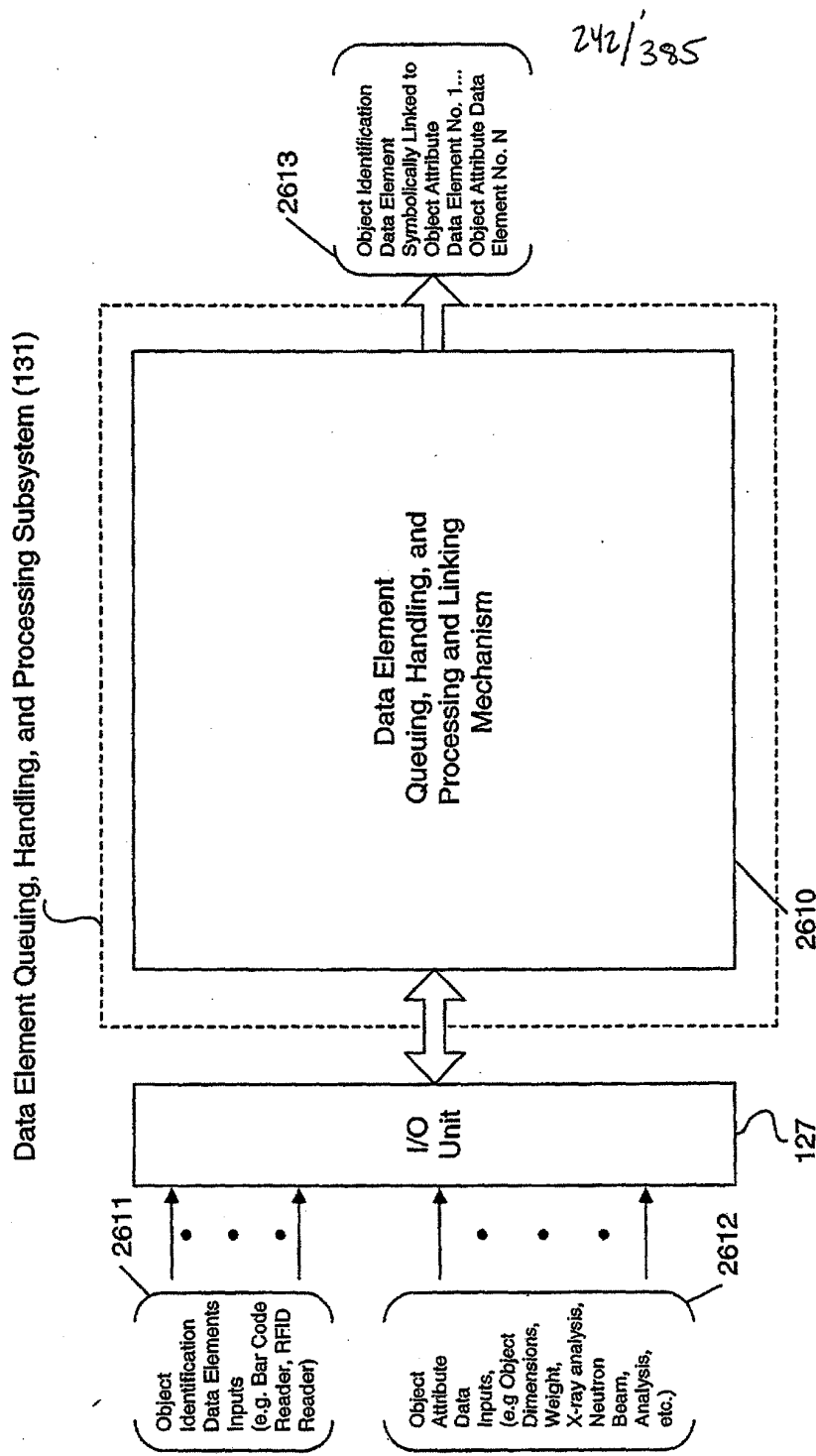


FIG. 25A

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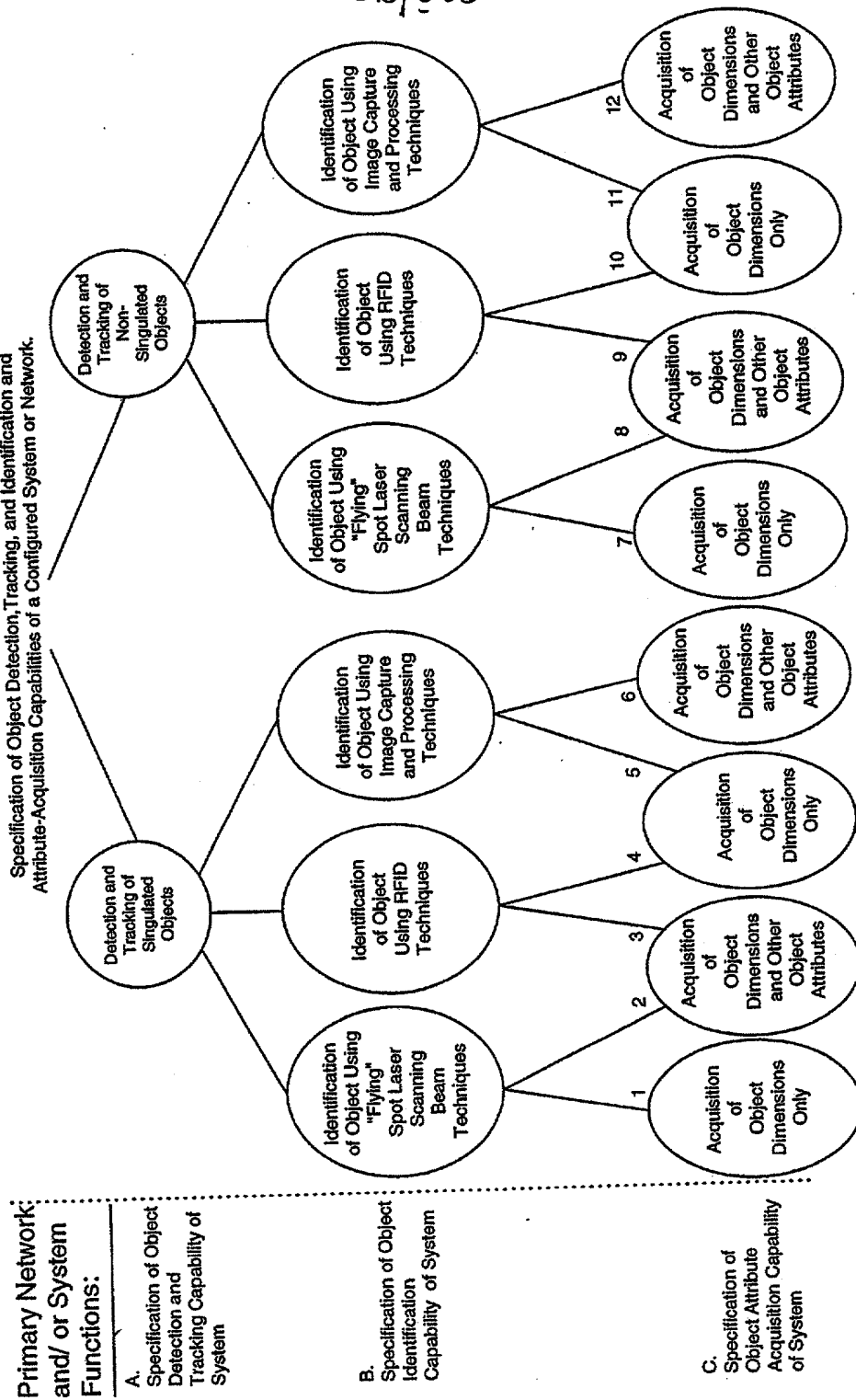


FIG. 25B

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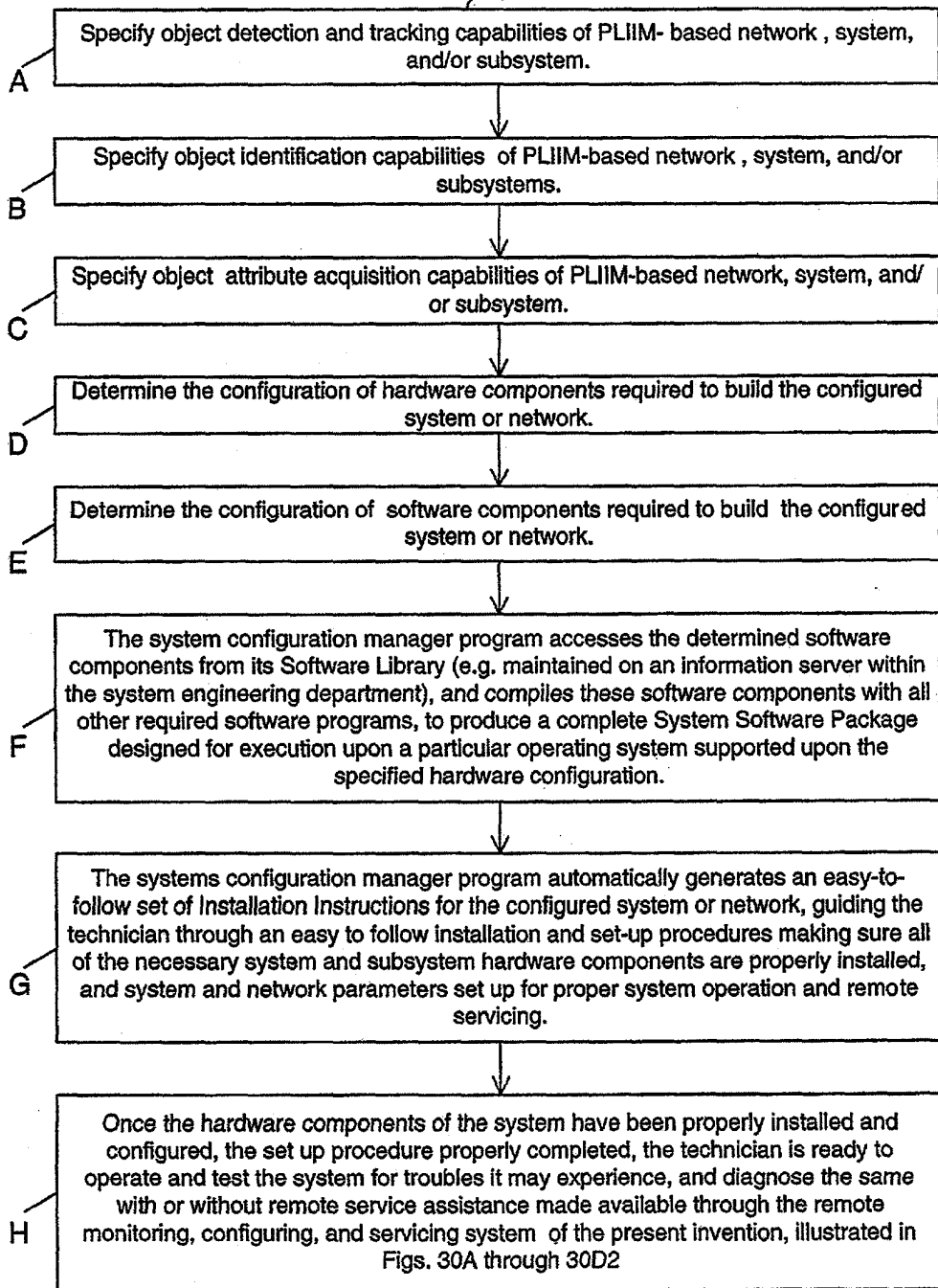
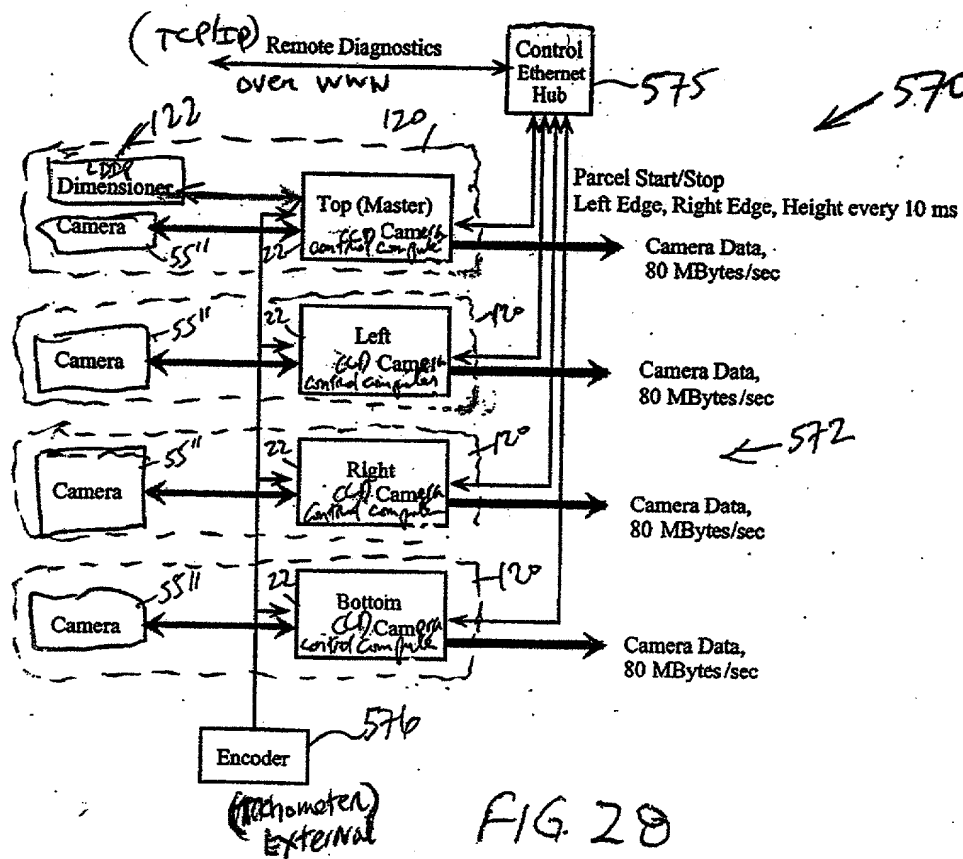
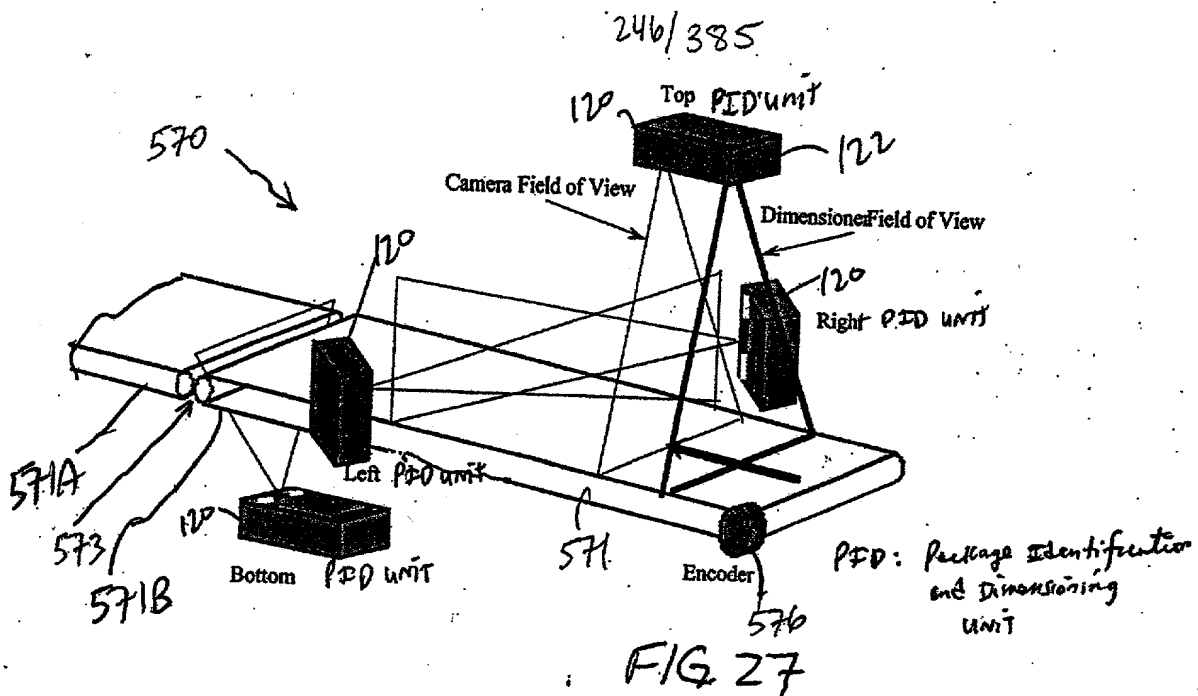


FIG. 25C

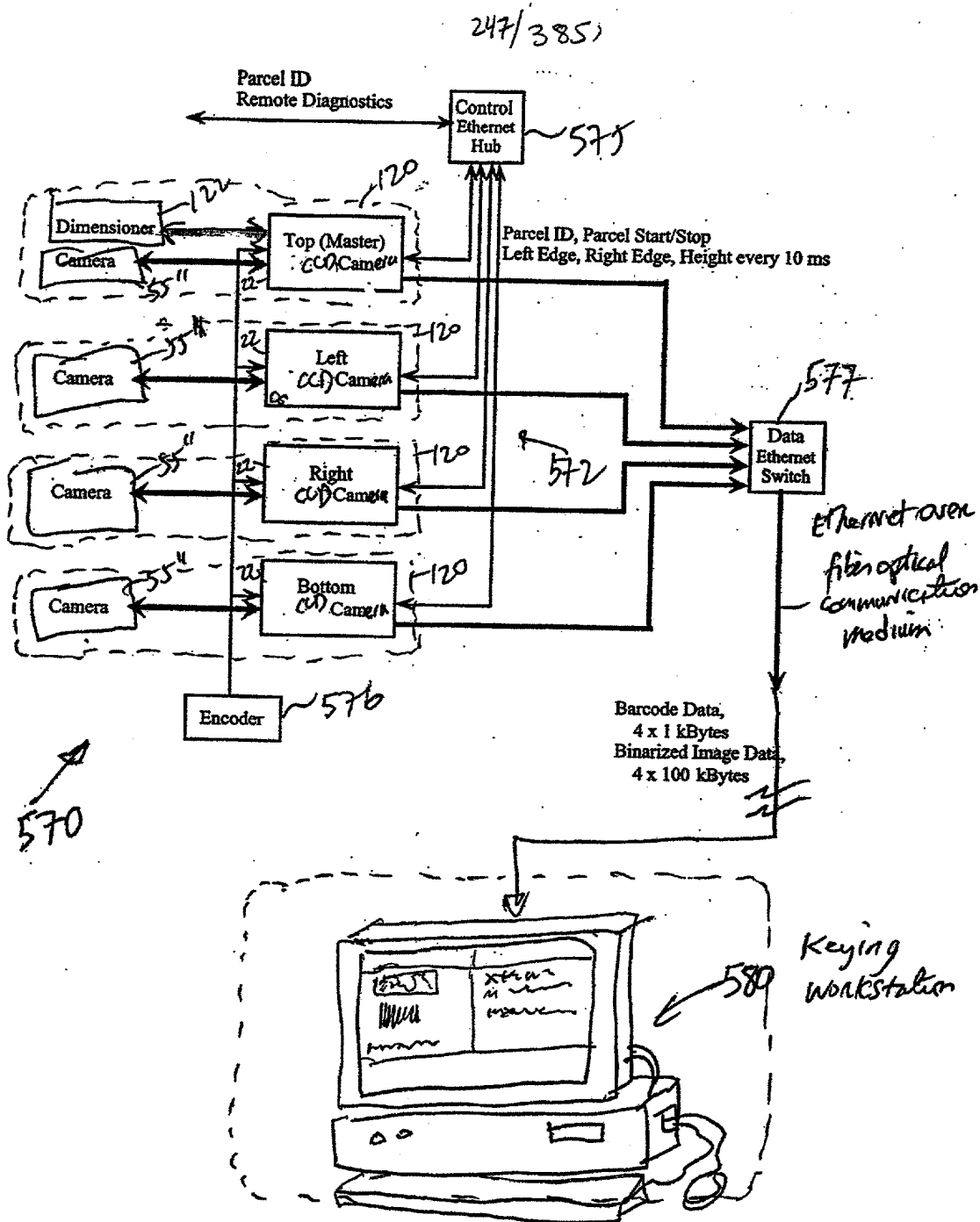




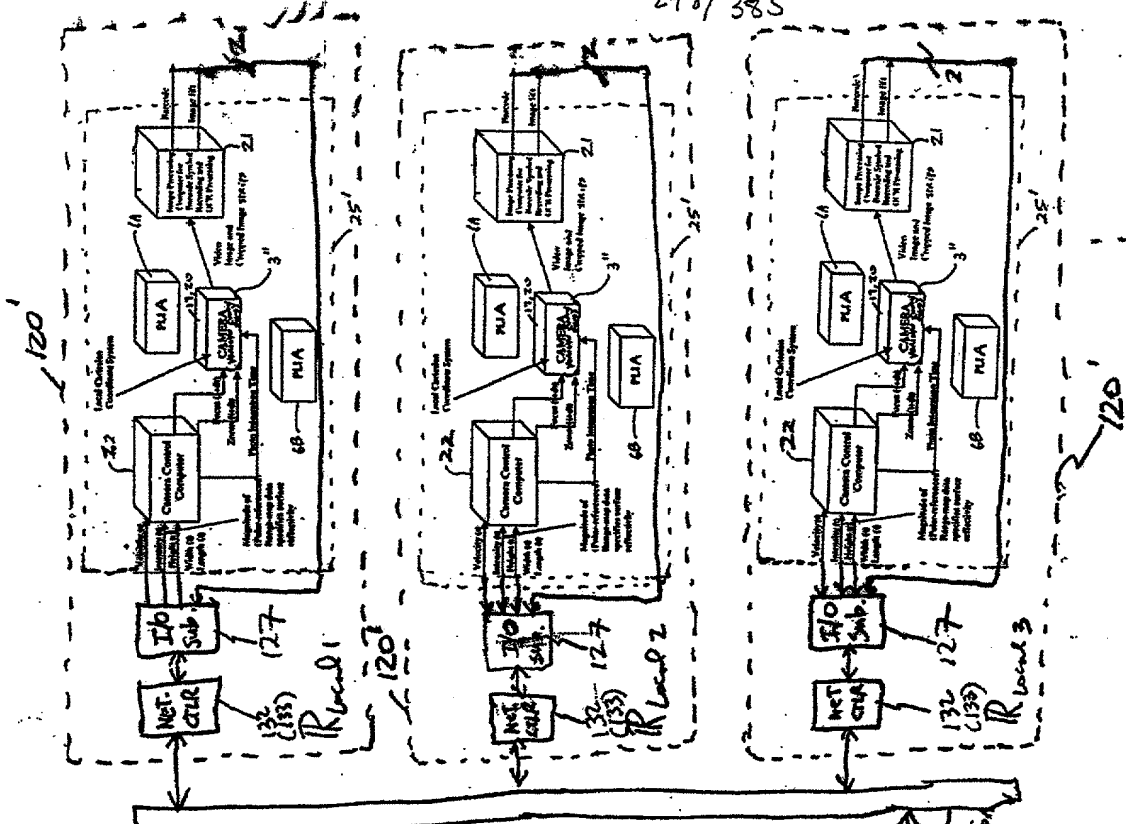
20200220 23485002



202020-29489001



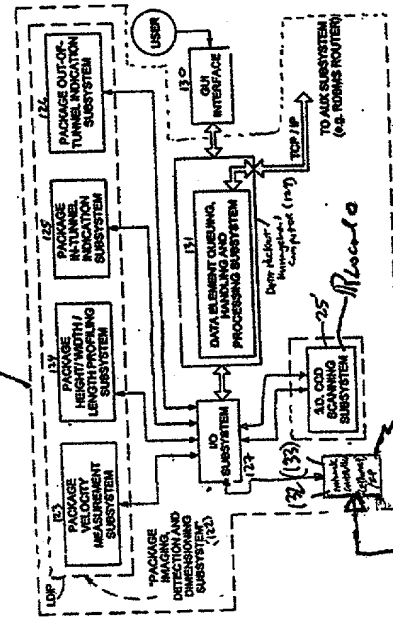
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570

572

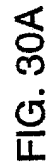
120

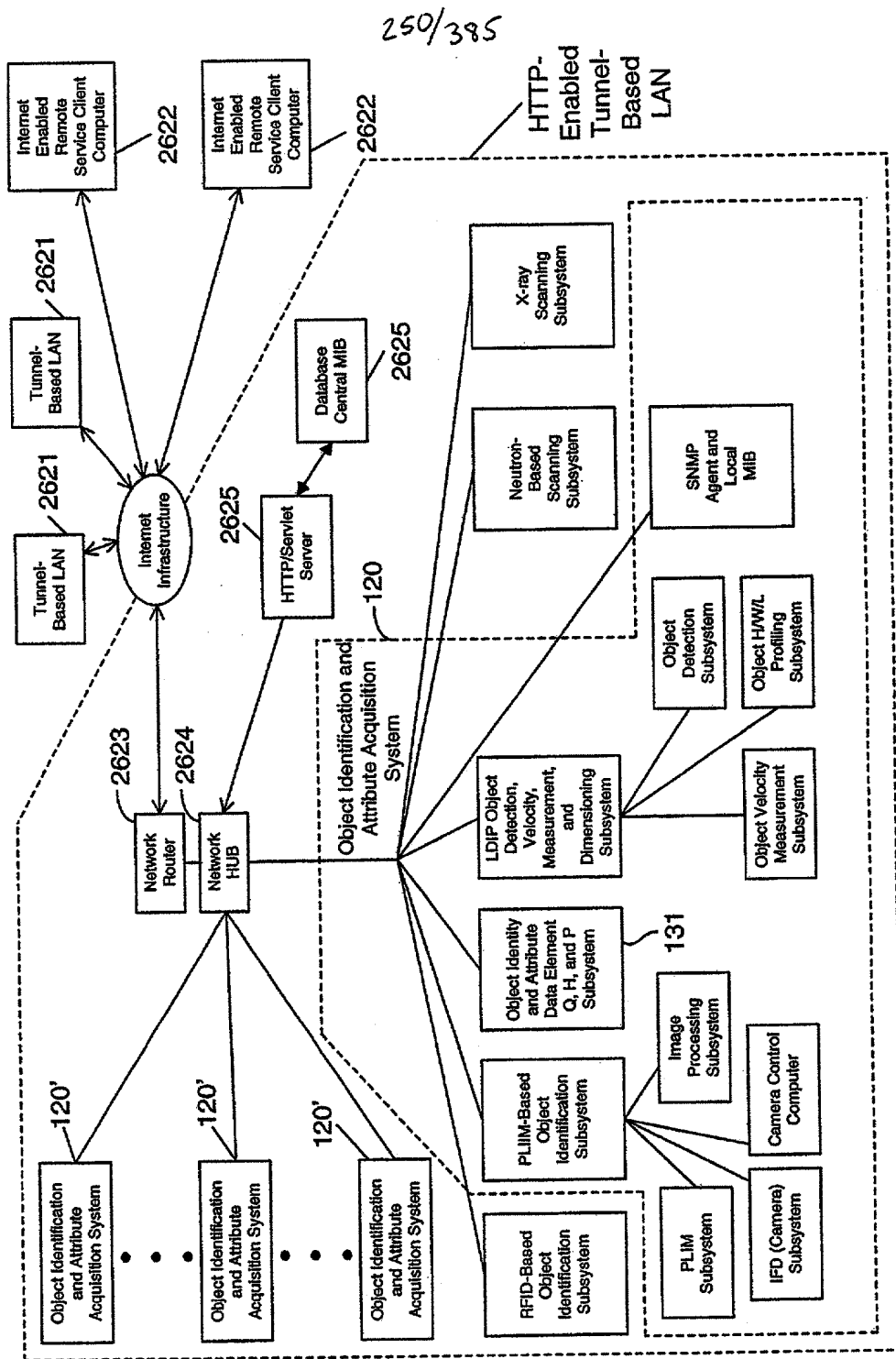


Coordinate Data  
Referenced  
with  
respect to  
Global  
(Velocity)  
(Intensity)  
(Height)  
(Width)  
(Length etc)

Network  
Communication  
Medium

FIG 30





**FIG. 30B**

### Network Configuration Parameters:

[ Router IP address; no. of nodes (i.e. systems) in LAN; passwords, LAN location; name of customer facility; technical contact; phone no.; domain name; object identity codes; object attribute acquisition codes;....]

### System Configuration Parameters:

[ System IP Address; passwords; object identity codes; object attribute acquisition codes;....]

### Monitorable and/or Configurable Parameters for Subsystems Within Each System:

- |   |   |
|---|---|
| These subsystems generate object identity parameters  | <input type="checkbox"/> PLIIM-based object identification subsystem: [ object identity code; object attribute acquisition codes;....]<br><input type="checkbox"/> PLIM Subsystem: [VLD status; power VLD; TIM function; temp;....]<br><input type="checkbox"/> IFD ( Camera) Subsystem: [sensor temp; ....]<br><input type="checkbox"/> Image Processing Subsystem (Computer): [processor load history; system up time; # of frames (pgs); barcode read rate; current line rate;....]<br><input type="checkbox"/> Camera Contact Subsystem (Computer): [number of frames dropped; number of focused zoom commands; number and kinds of motor control errors;....]                                |
| This system links object attribute data element parameters (i.e. object identity data element) to corresponding object identity parameters (i.e. object attribute data element) | <input type="checkbox"/> RFID-based object identification subsystem: [....]<br><input type="checkbox"/> Object identity and attribute data element queuing, handling and processing subsystem: [....]<br><input type="checkbox"/> LDIP object identification, velocity-measurement, and dimensioning subsystem: [....]<br><input type="checkbox"/> Object velocity measurement subsystem: [polygon RPM; polygon laser output X; channel X drift; channel X noise; trigger error events; instant lock reference drift; temperature]<br><input type="checkbox"/> Object H/W/L profiling subsystem<br><input type="checkbox"/> Object detection subsystem: [non- singulation/ singulation code;....] |
| These subsystems generate object attribute parameters   | <input type="checkbox"/> X-ray scanning subsystem: [....]<br><input type="checkbox"/> Neutron-beam scanning subsystem: [....]   |

FIG. 30C

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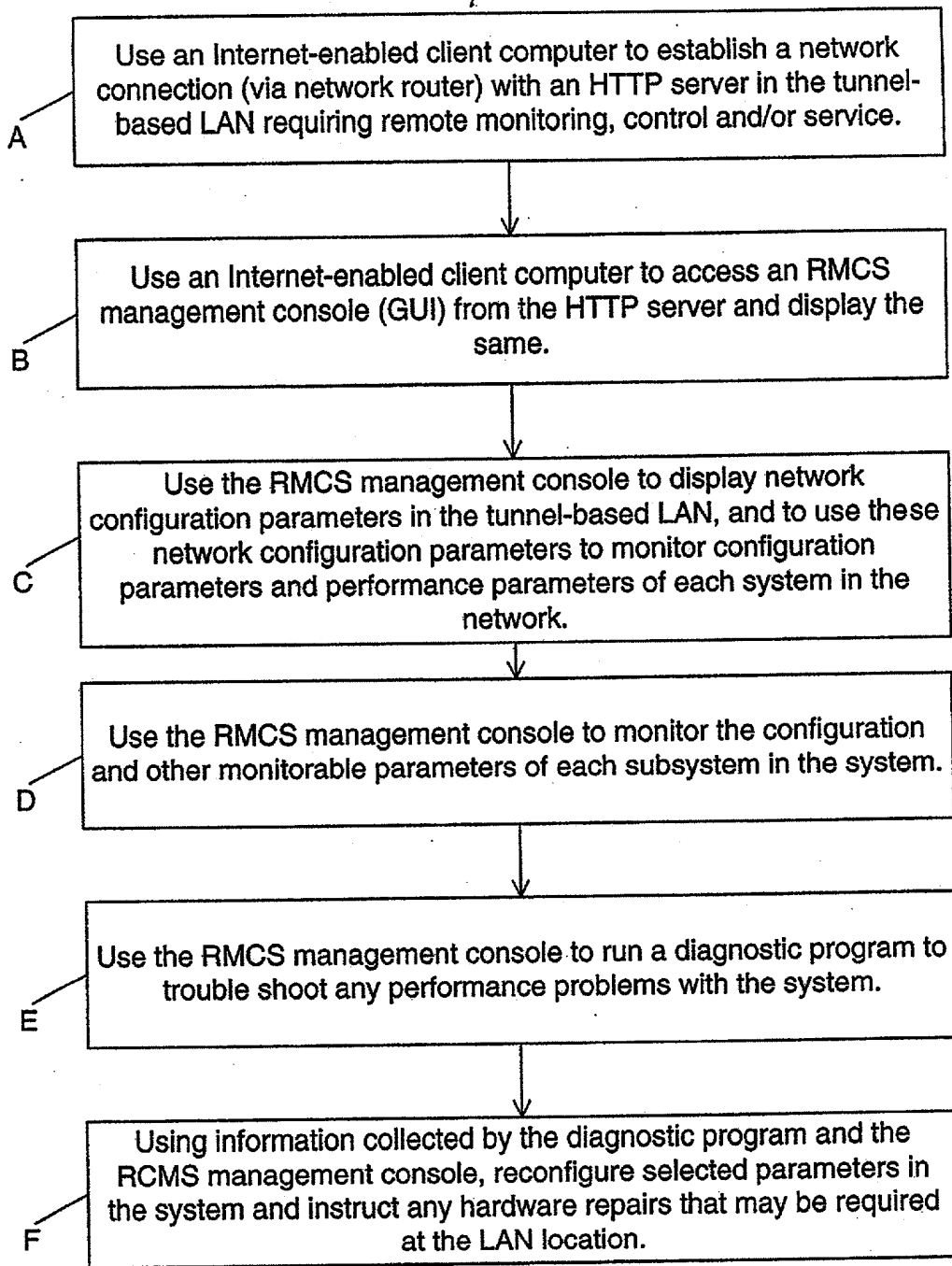


FIG. 30D1



253/385 (A)

G

Use the RMCS management console to rerun diagnostic programs on troubled systems and subsystems in the LAN after parameter reconfiguration and/or hardware repair at the LAN location, so as to test the performance of such systems and subsystems and the overall tunnel based LAN.

H

Use the RMCS management console to monitor parameters of the system and subsystems in the tunnel based LAN, from time to time, to determine whether or not the system and/or network tunnel is required.

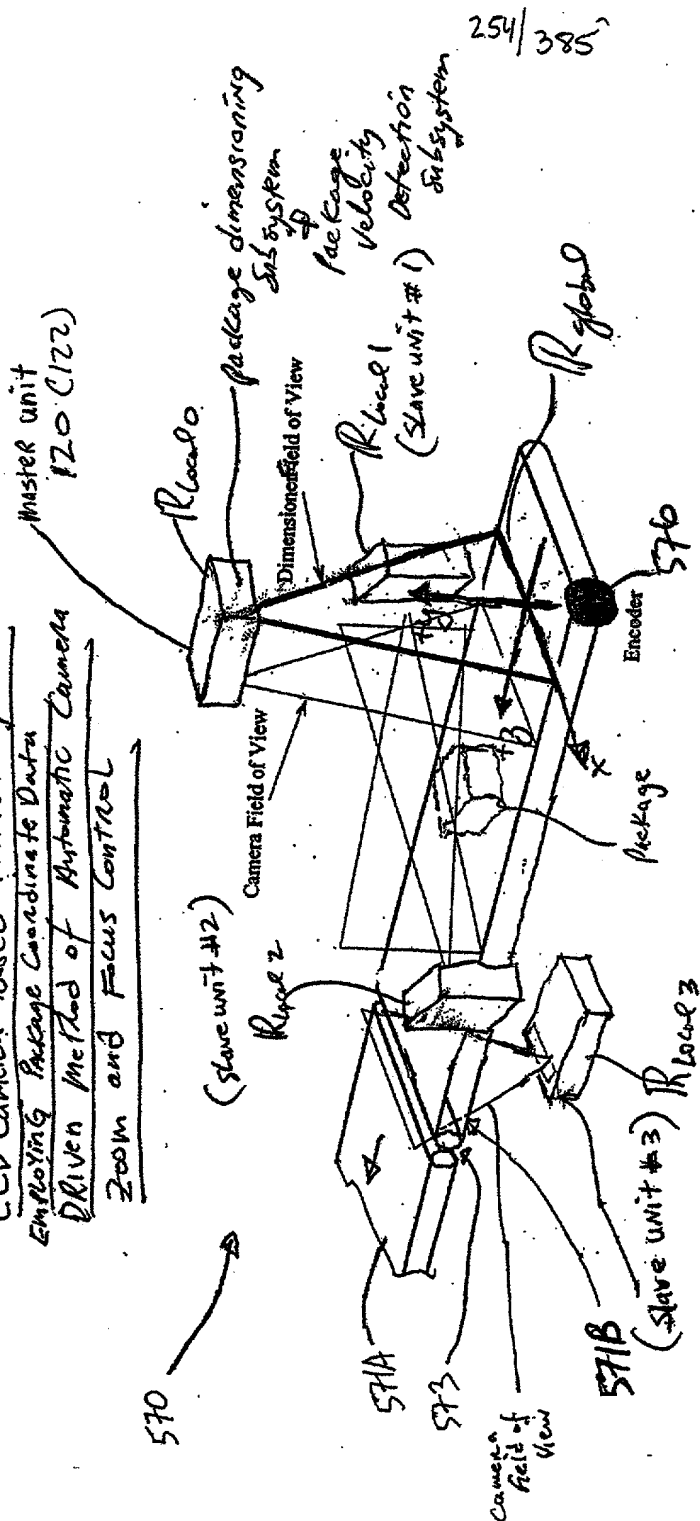
I

Use the RMCS management console to record all monitored parameter records and result of diagnostic programs in a customer service database for future reference, and access during subsequent remote service calls over the Internet.

FIG. 30D2

106653-23

# CCD Camera-Based Tunnel System Employing Passage Coordinate Data Driven Method of Automatic Camera Zoom and Focus Control



Package coordinate data //  $HG \Rightarrow$  Package coordinate data //  $R_{local}$   
Regional

FIG. 31

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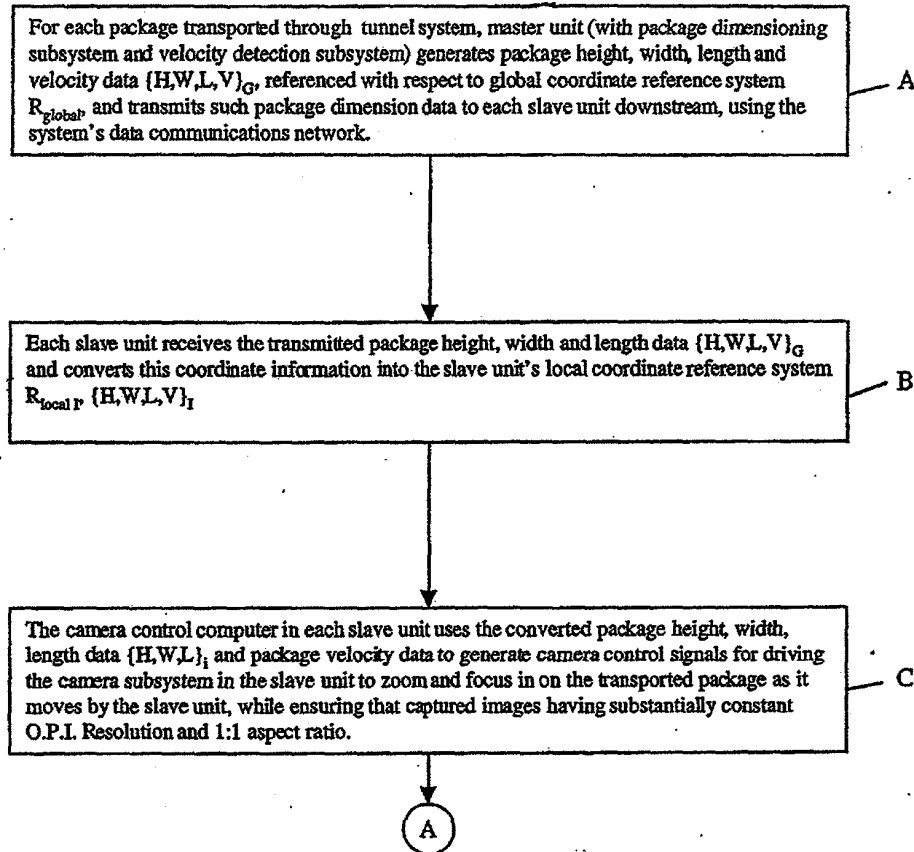


FIG. 32A

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Each slave unit captures images acquired by its intelligently controlled camera subsystem, buffers the same, and processes the images to decode bar code symbol identifiers represented in said images, and/or to perform optical character recognition (OCR) thereupon.

D

The slave unit which decodes a bar code symbol in a processed image automatically transmits a package identification data element (containing symbol character data representative of the decoded bar code symbol) to the master unit (or other designated system control unit employing data element management functionalities) for package data element processing.

E

Master unit time-stamps received package identification data element, places said data element in a data queue, and processes package identification data elements and time-stamped package dimension data elements in said queue to link each package identification data element with one said corresponding package dimension data element.

F

FIG. 32B

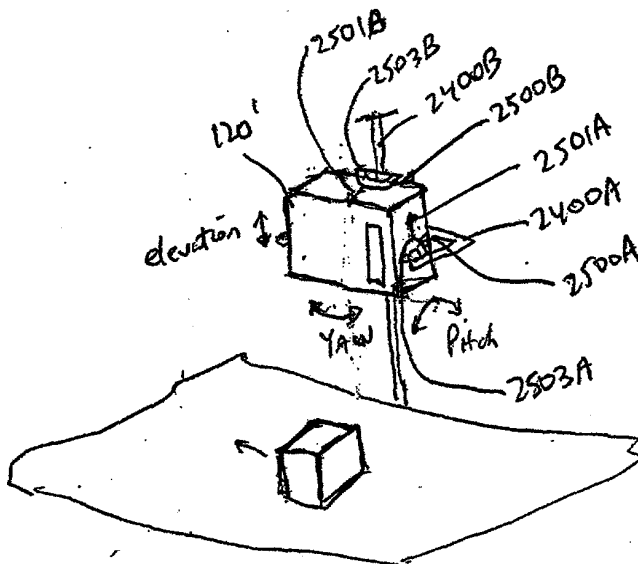
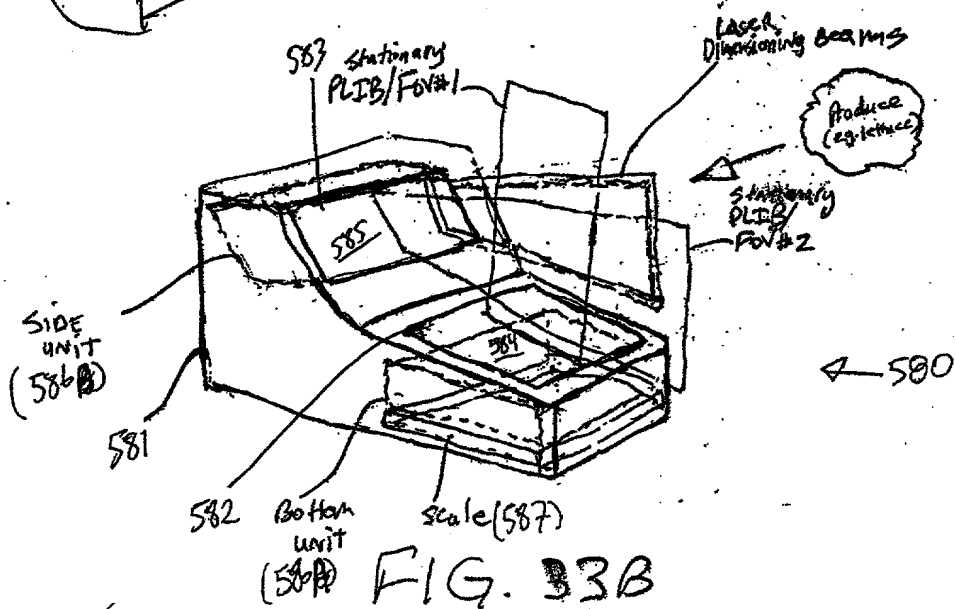
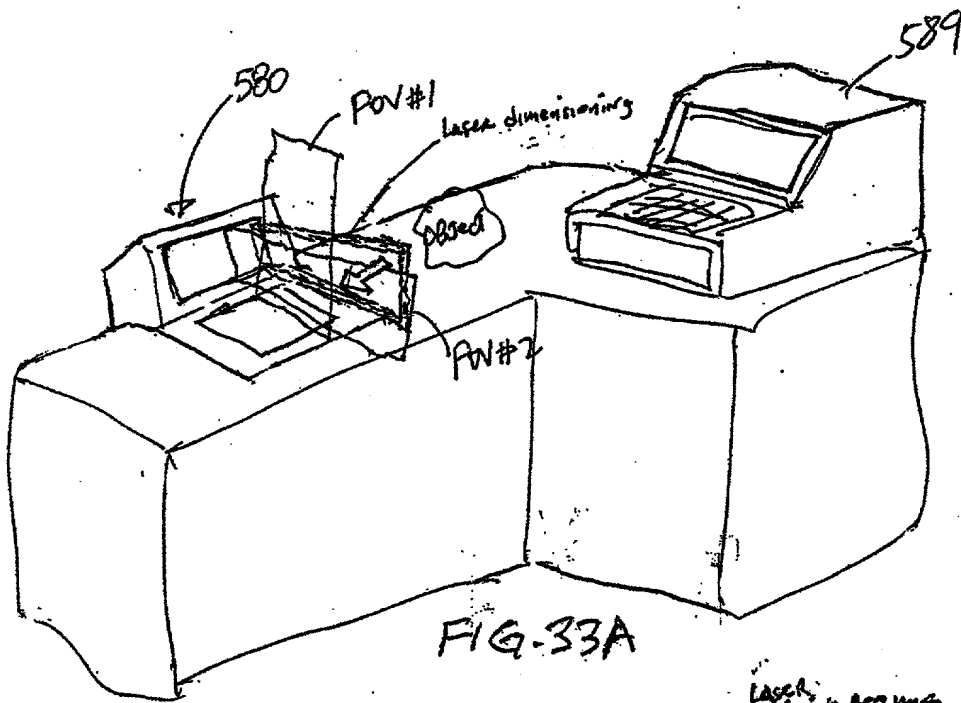
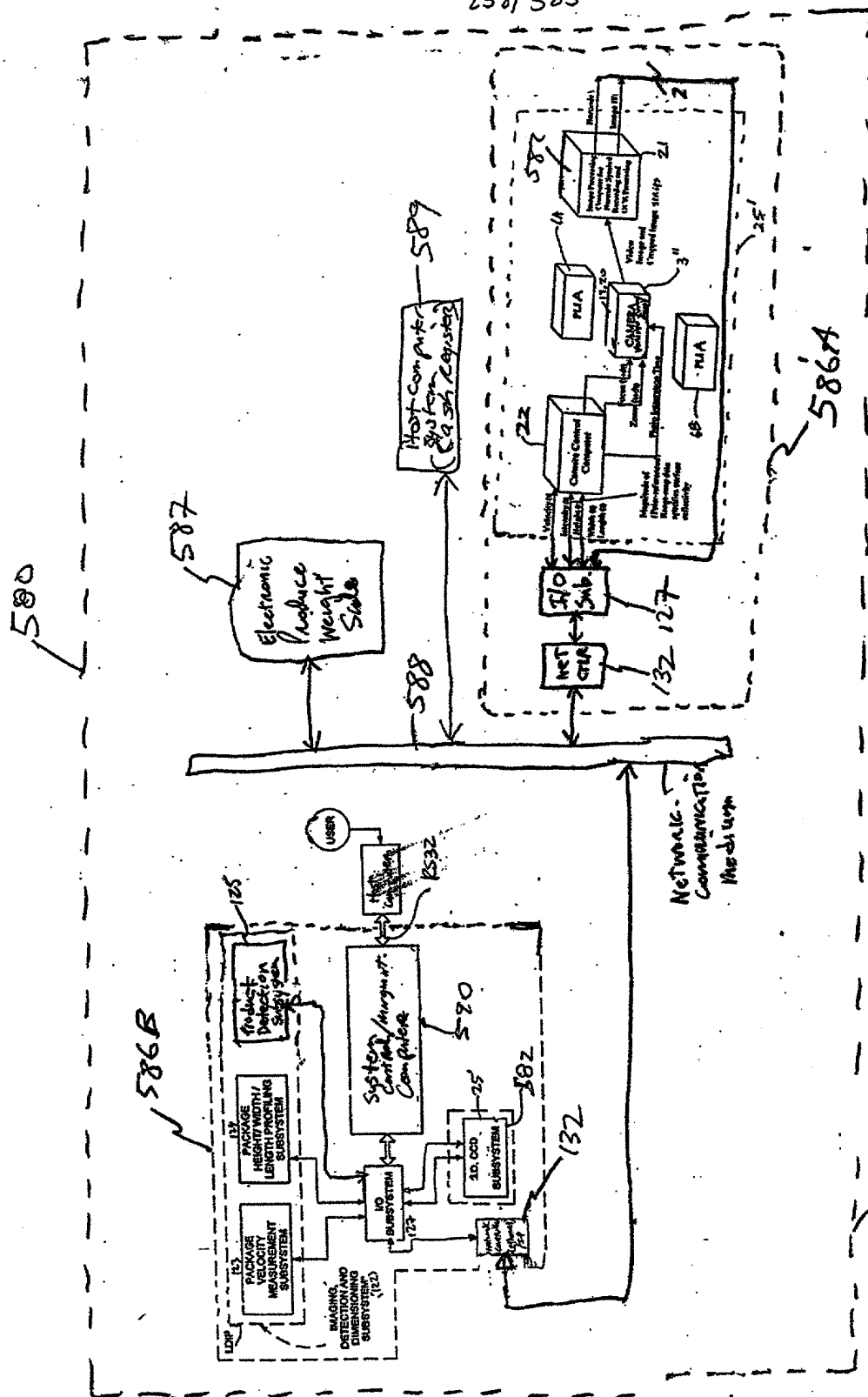


FIG. 31A

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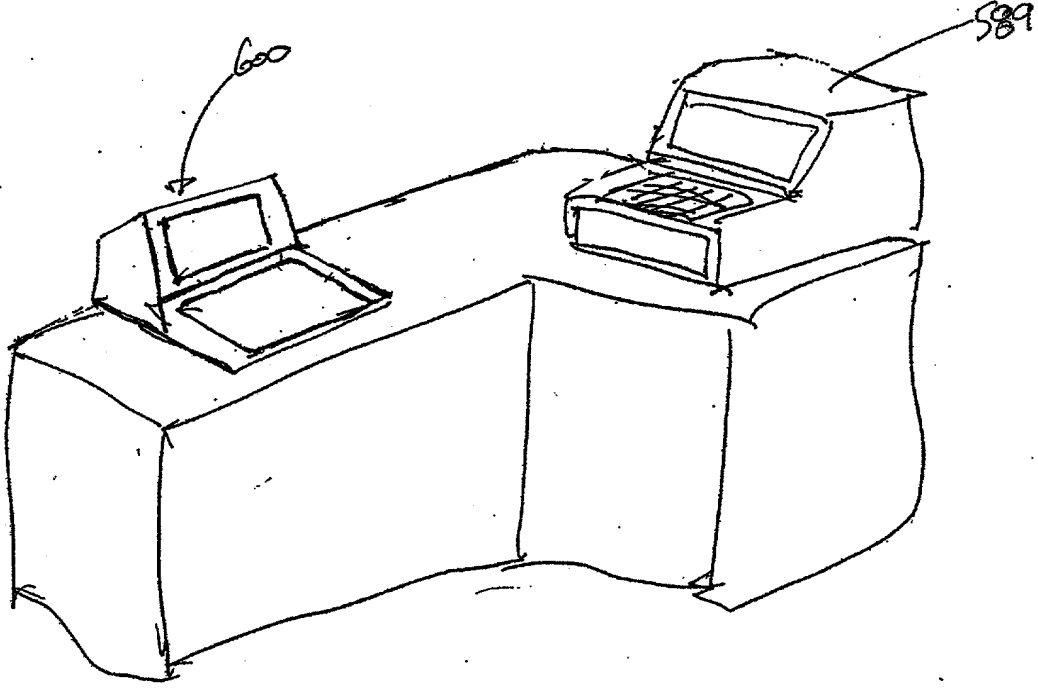


FIG. 34A

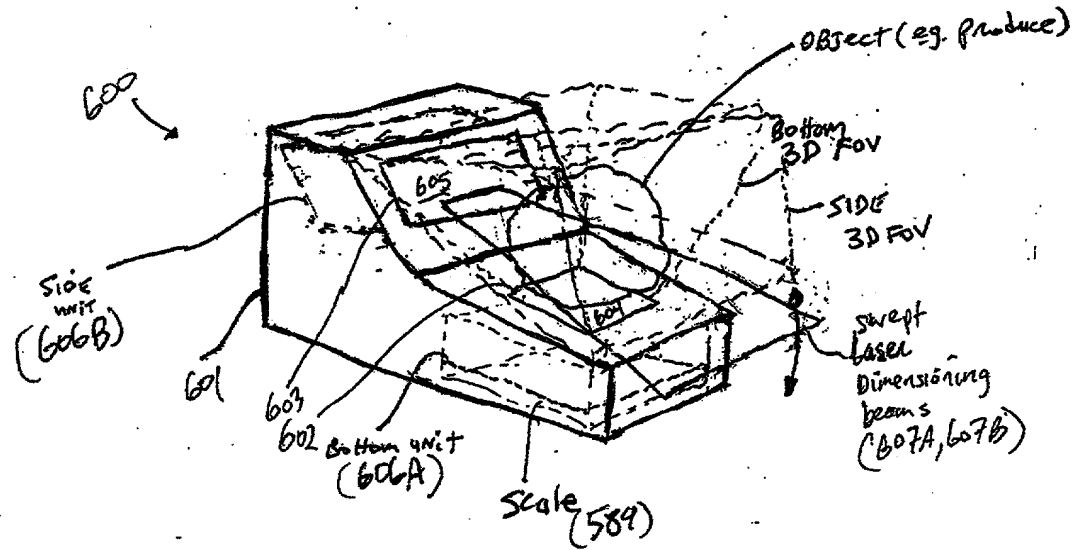
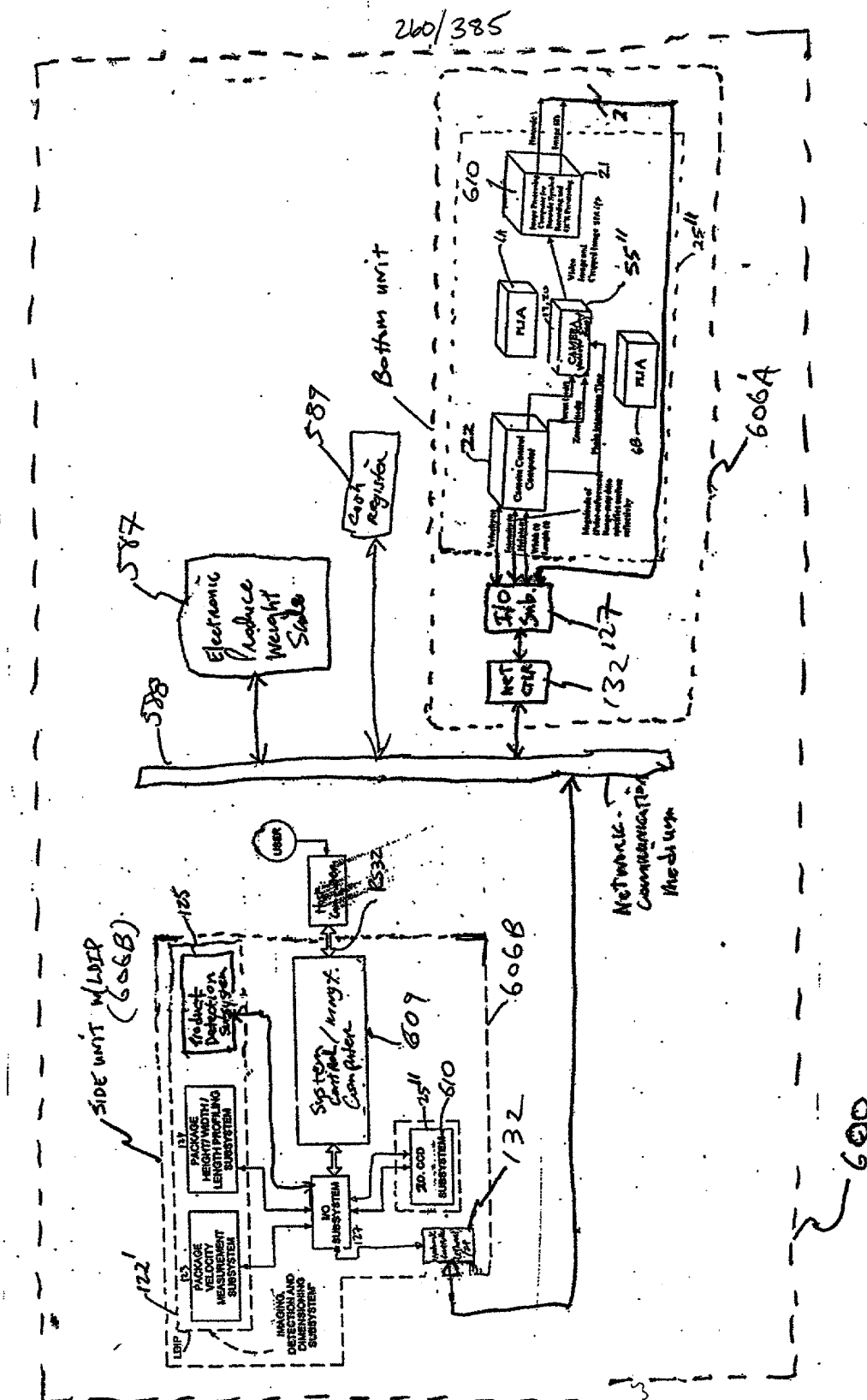


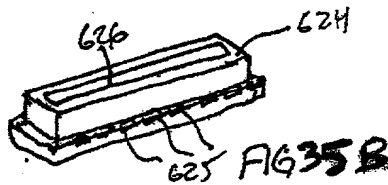
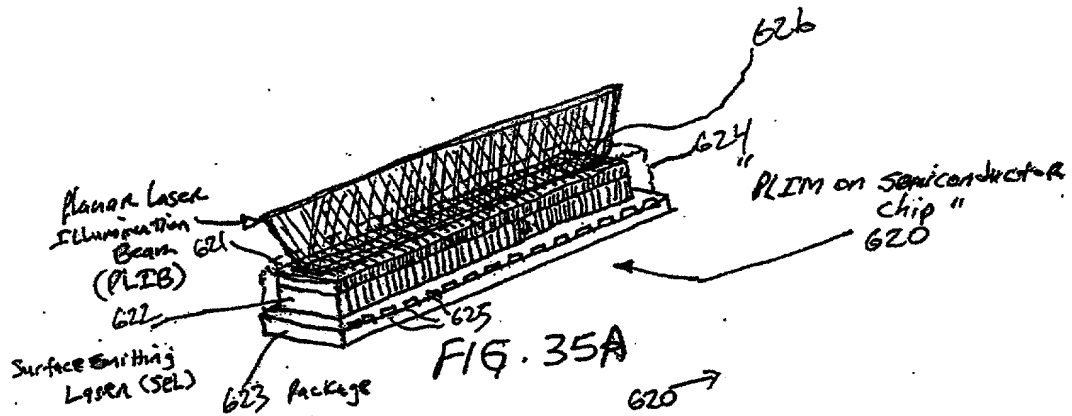
FIG. 34B

**NOBLESSE**





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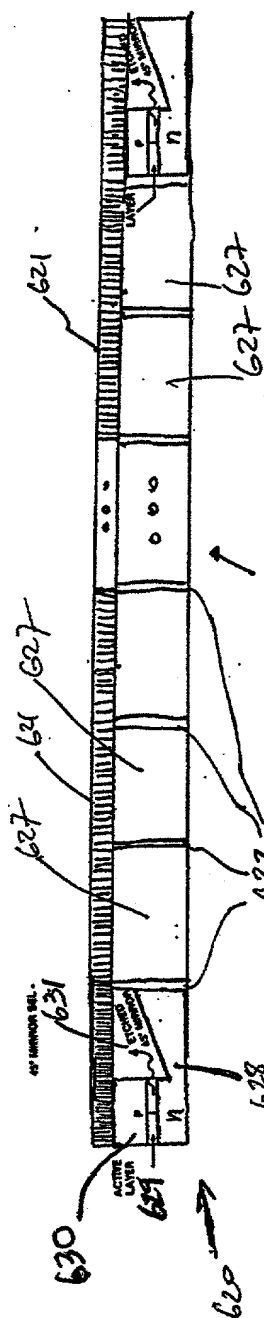


FIG. 35A

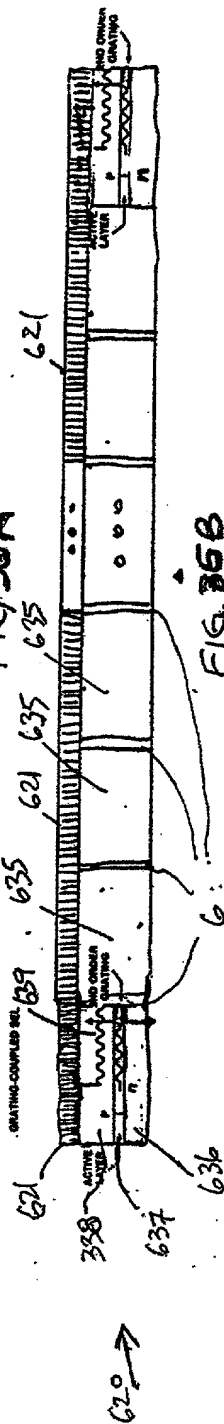


FIG. 35B

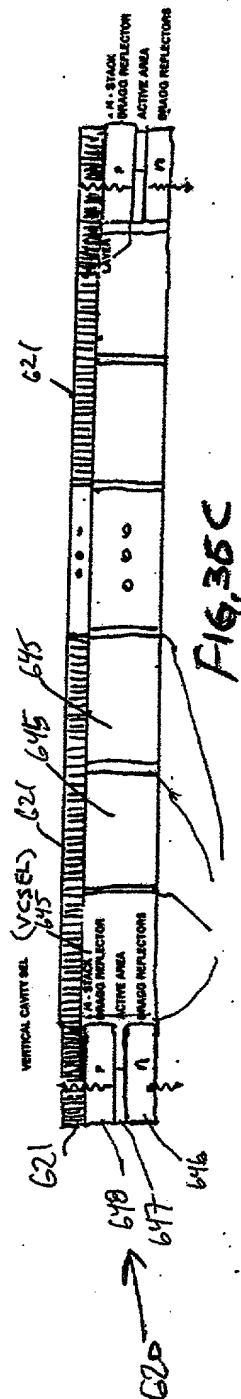


FIG. 35C

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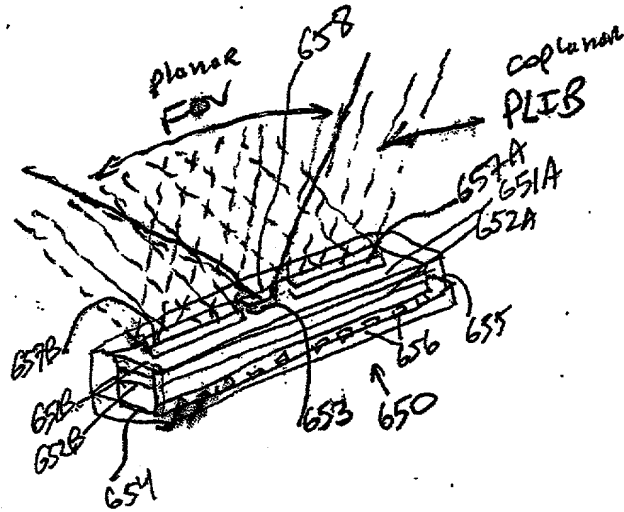


FIG. 37

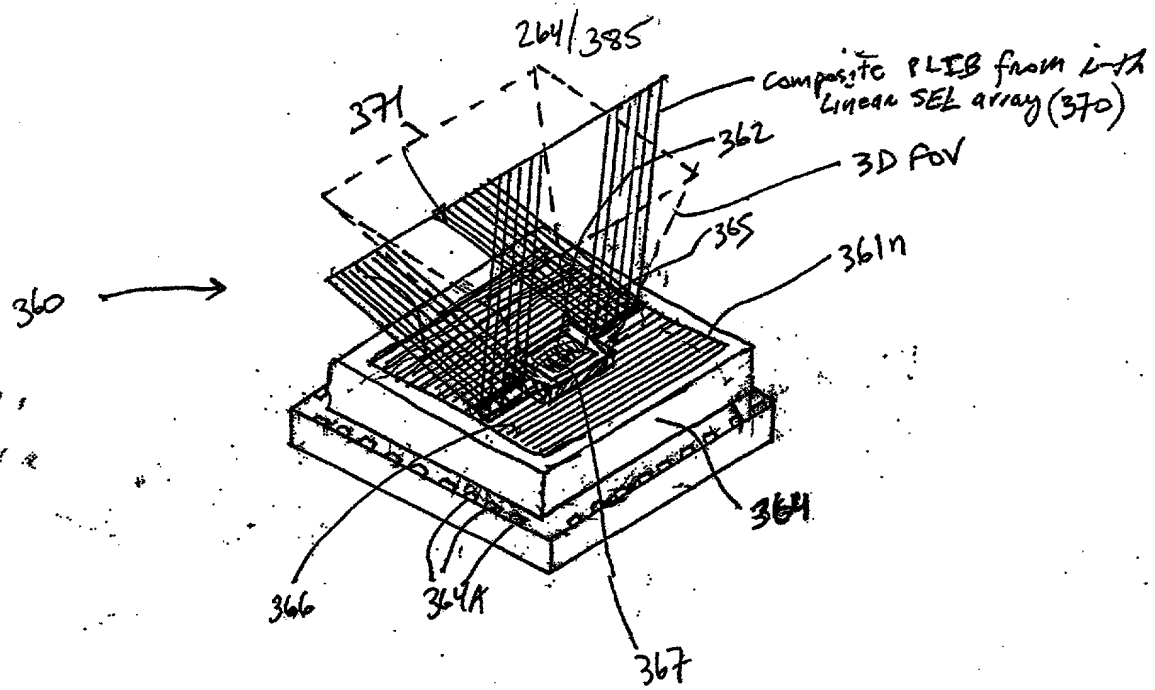


FIG. 38A

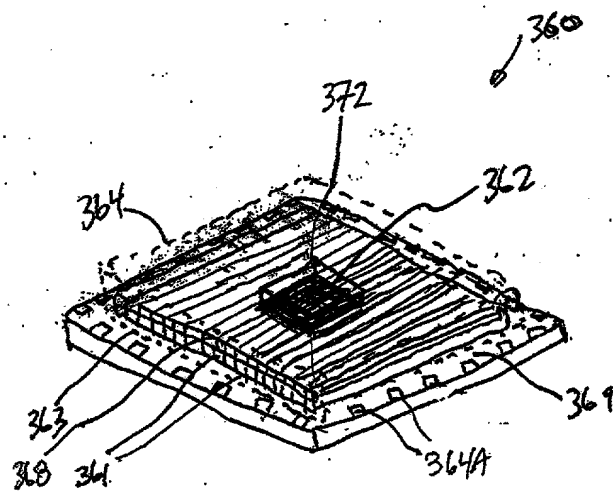


FIG. 38B

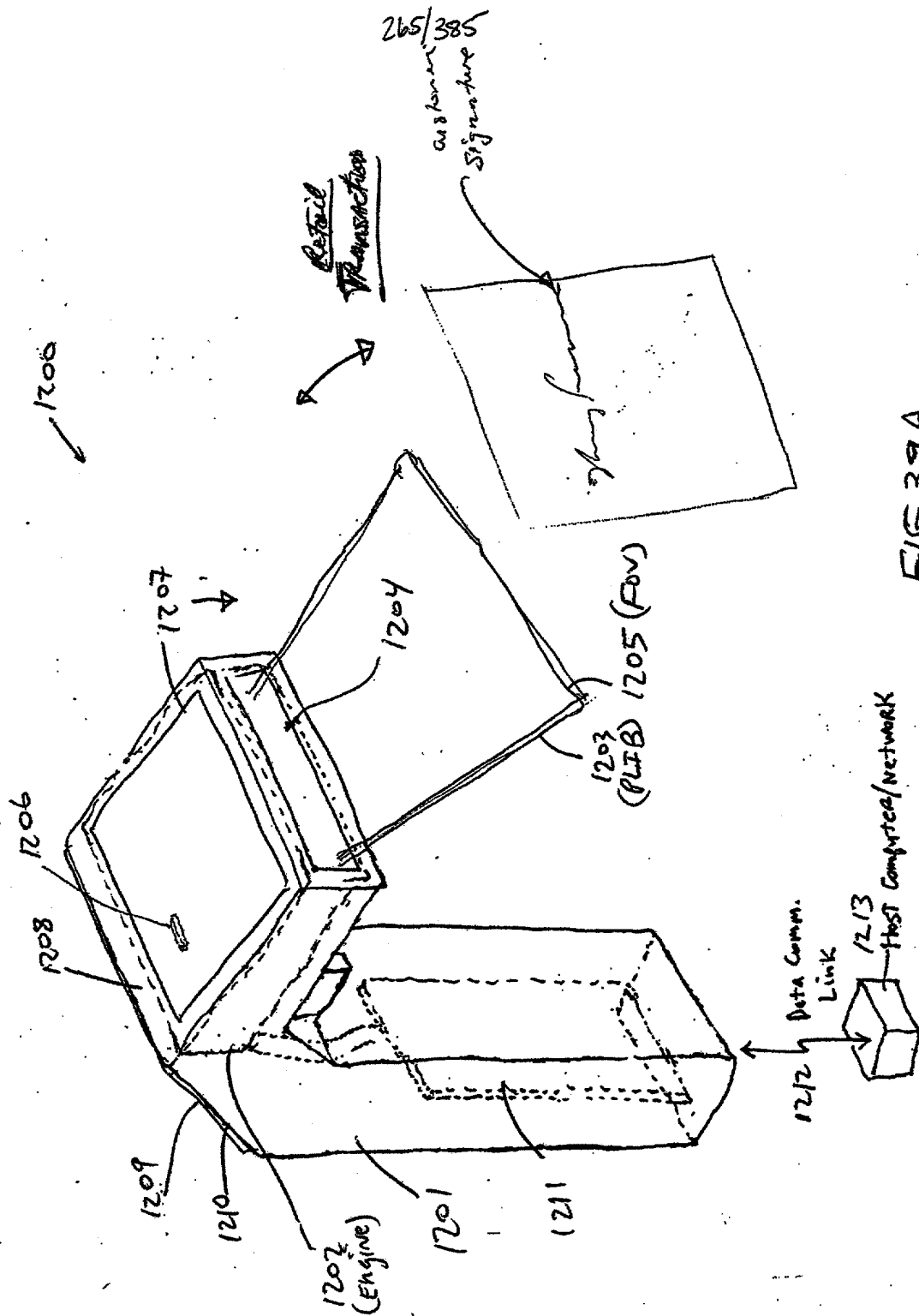


FIG. 39A

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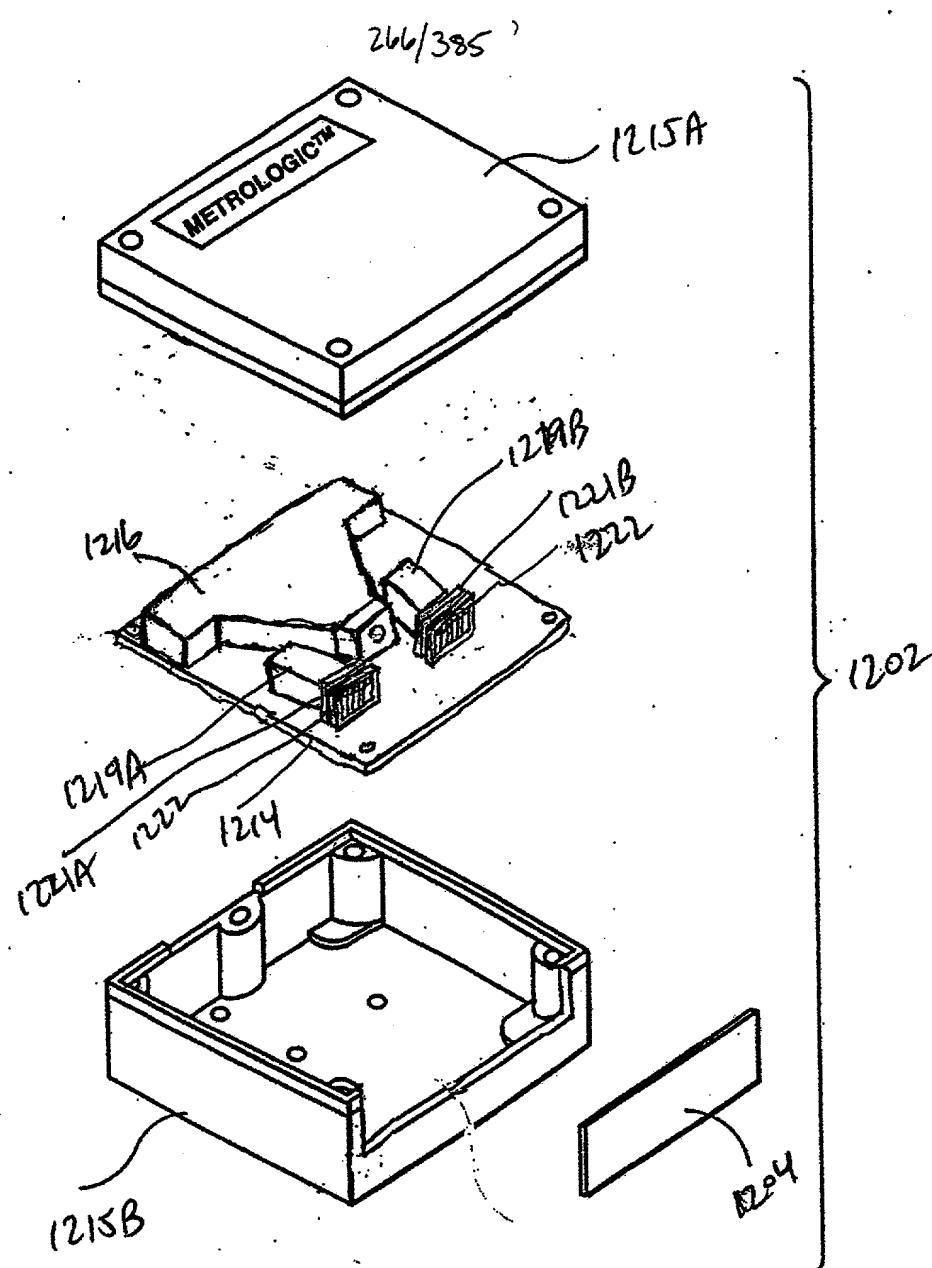


FIG. 39B

10058462.020702

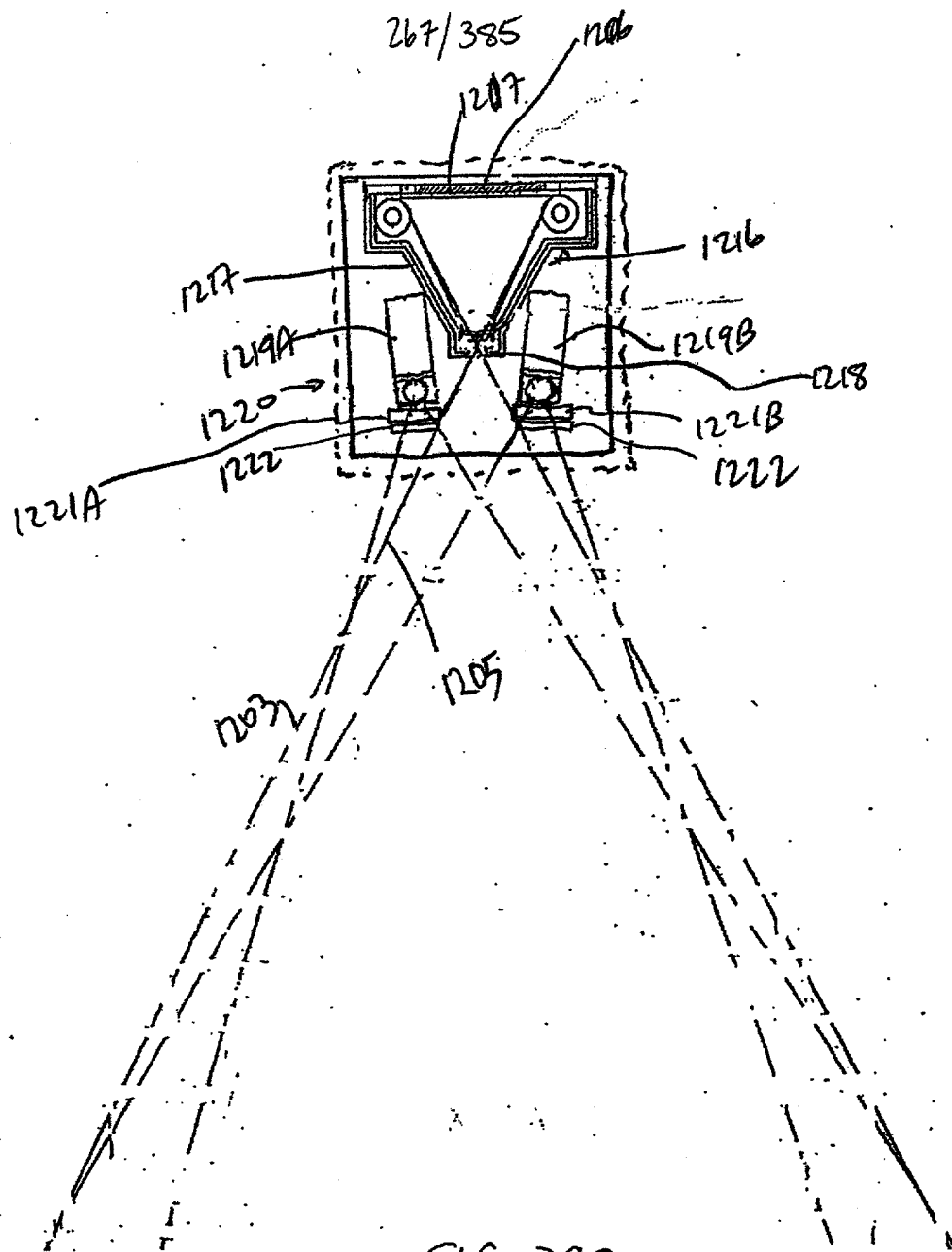


FIG. 39C

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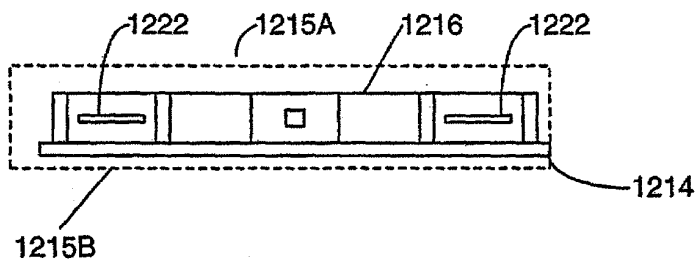


FIG. 39D

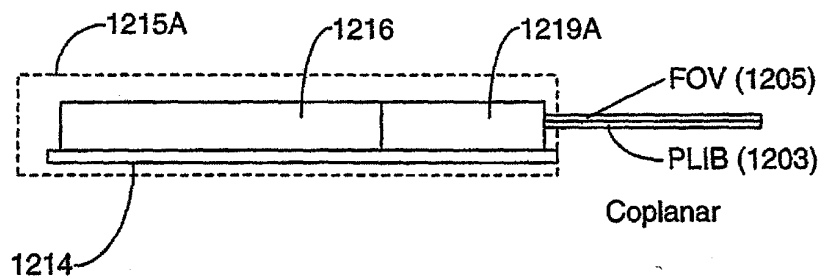


FIG. 39E

2020-09-29 10:06:52.020702



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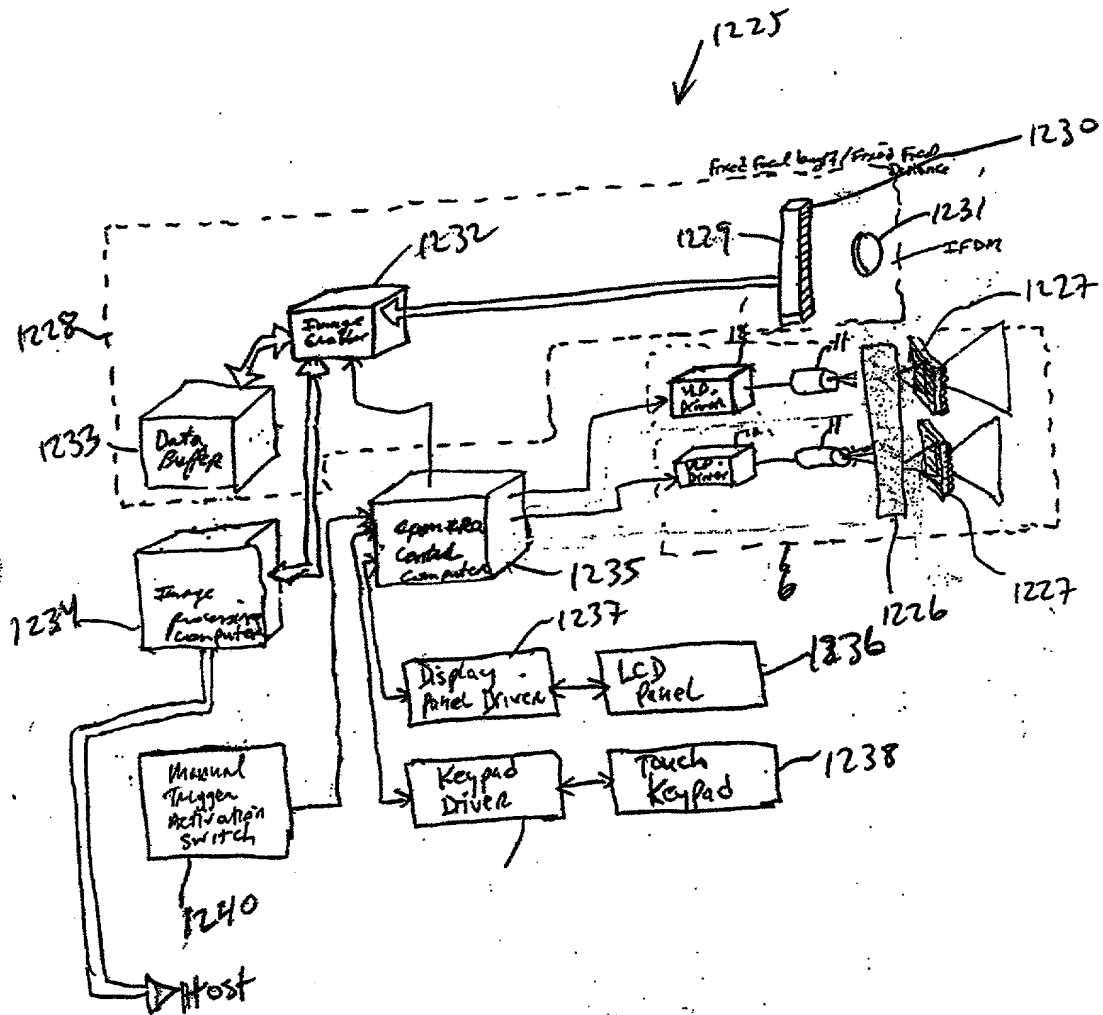
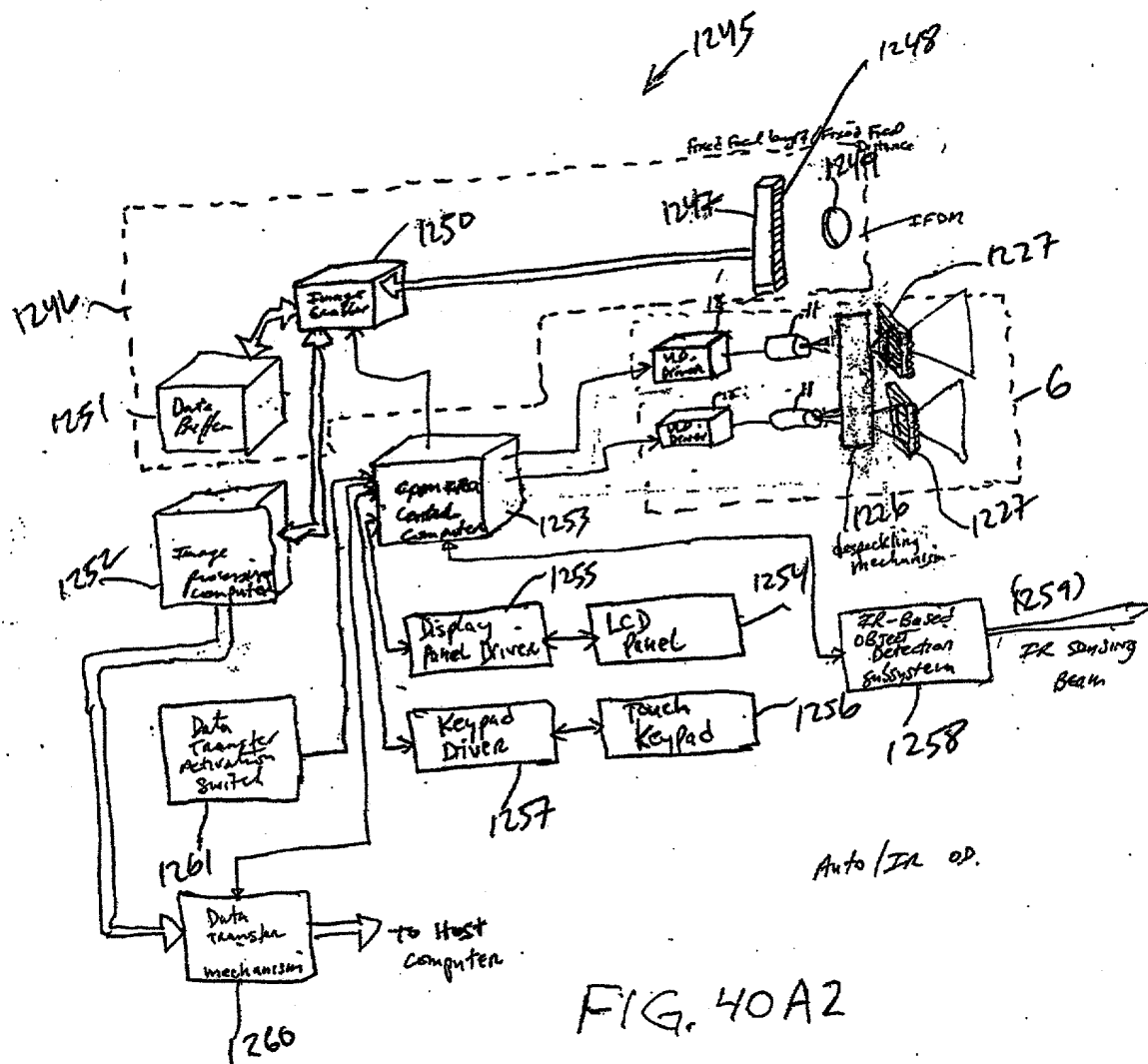
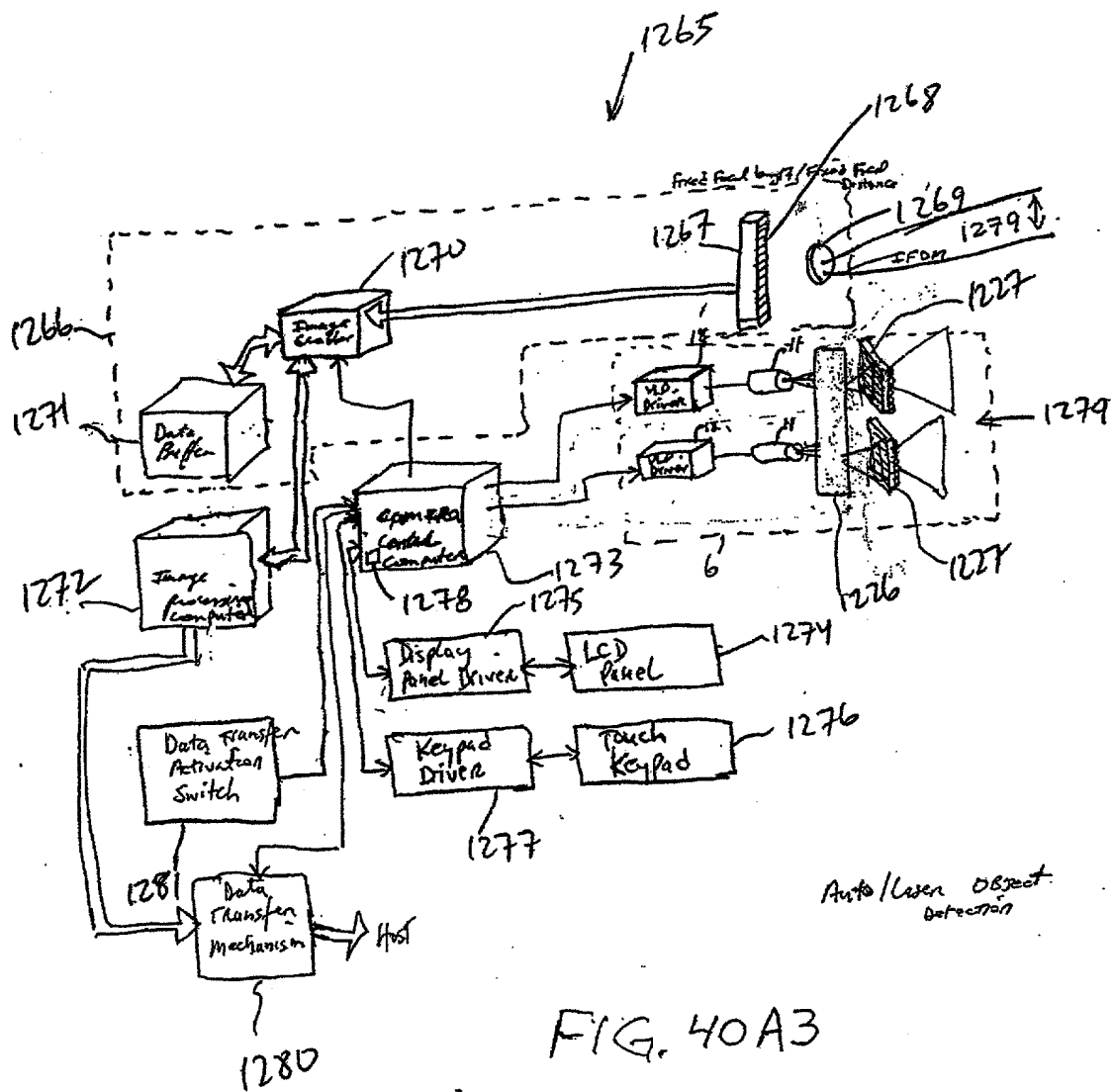


FIG. 40A1

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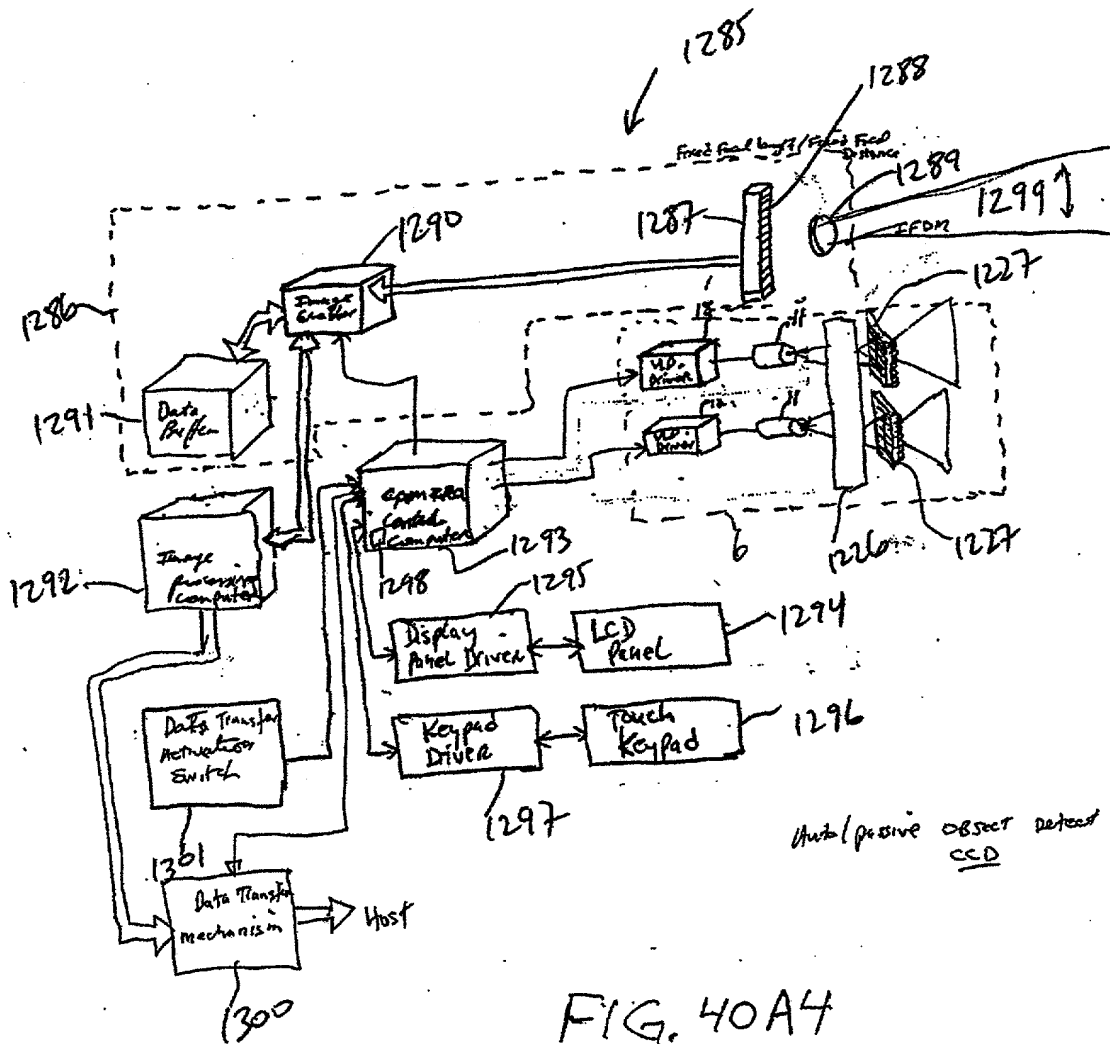


FIG. 40A4

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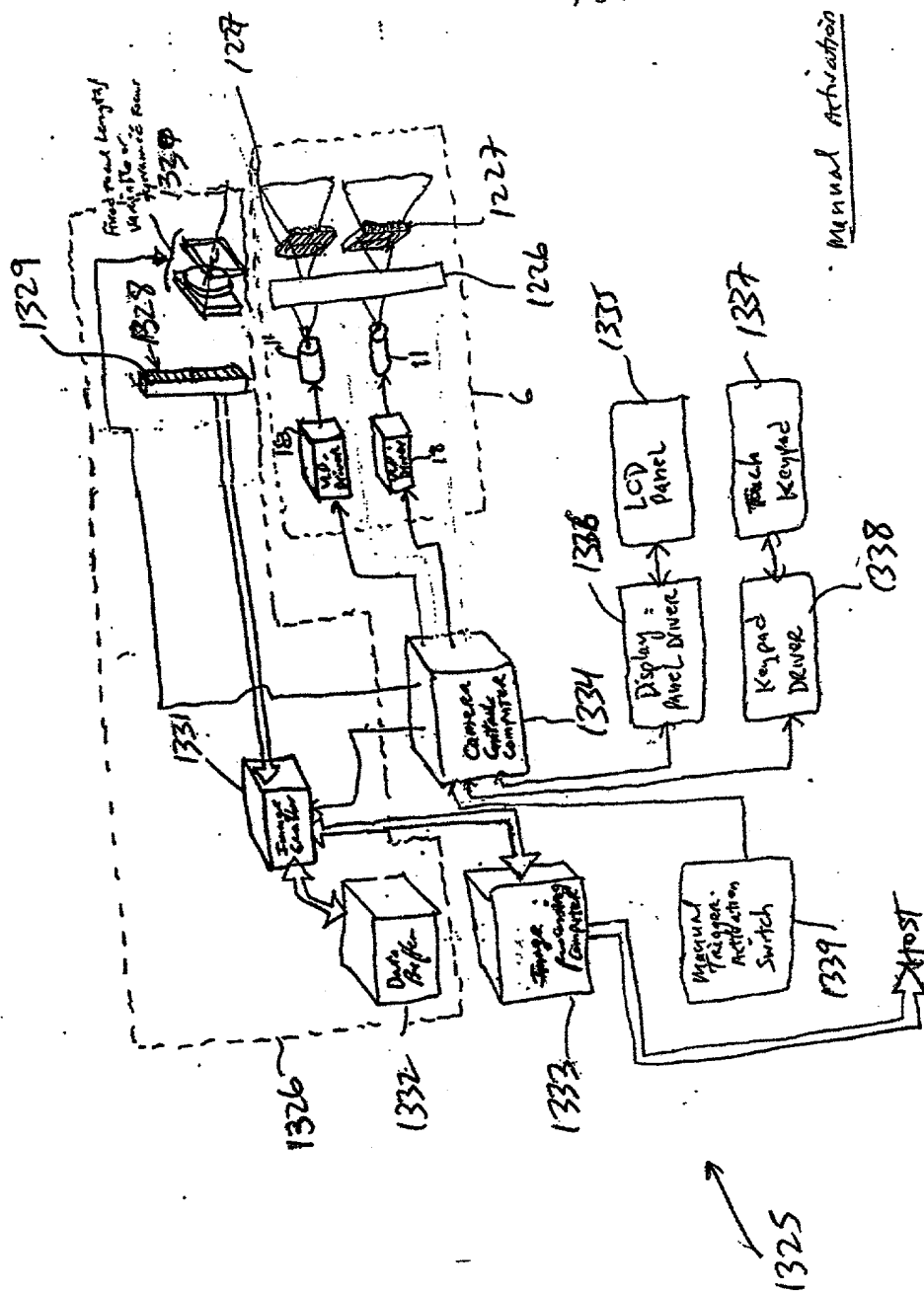


FIG. 40B1

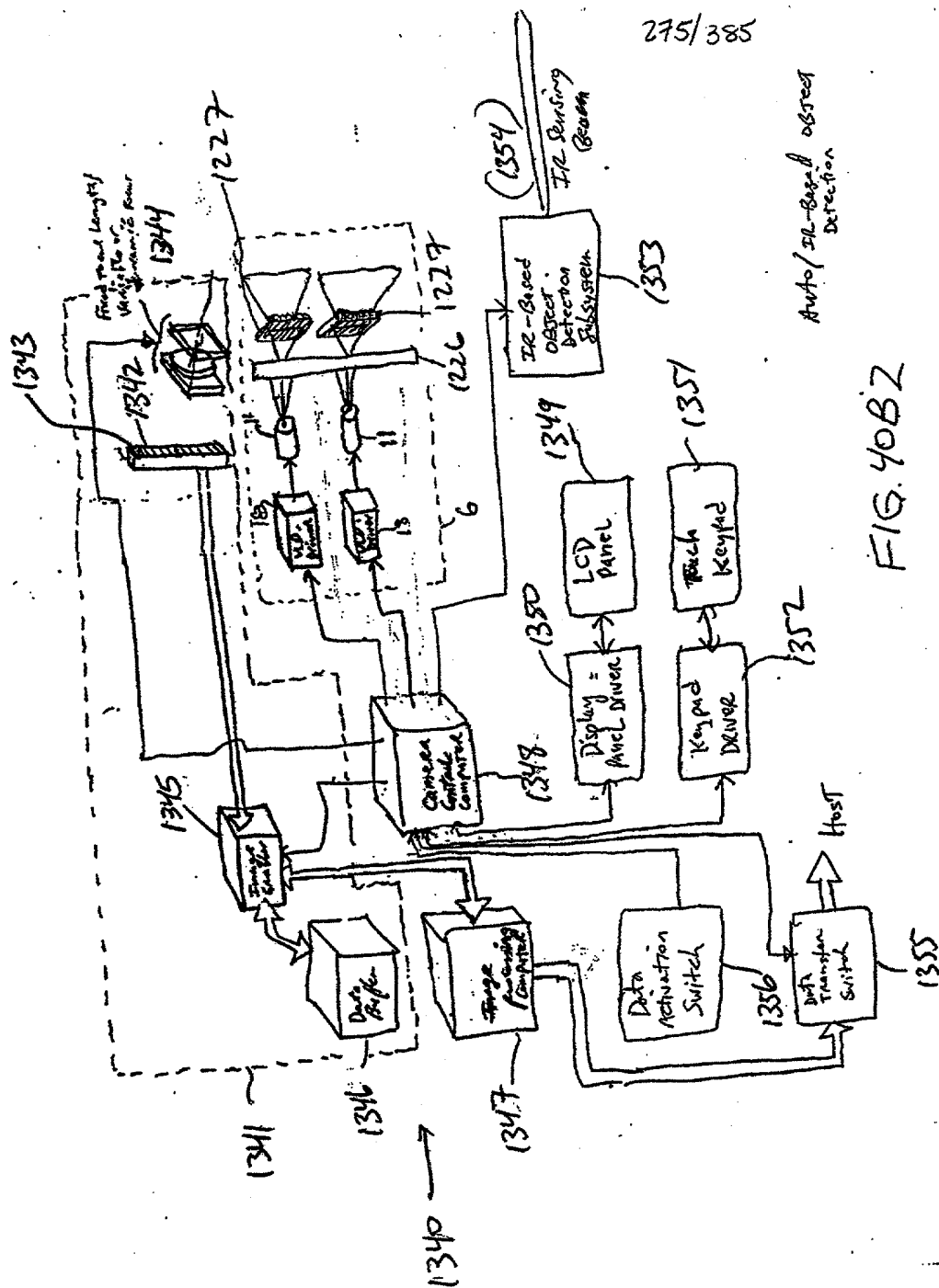
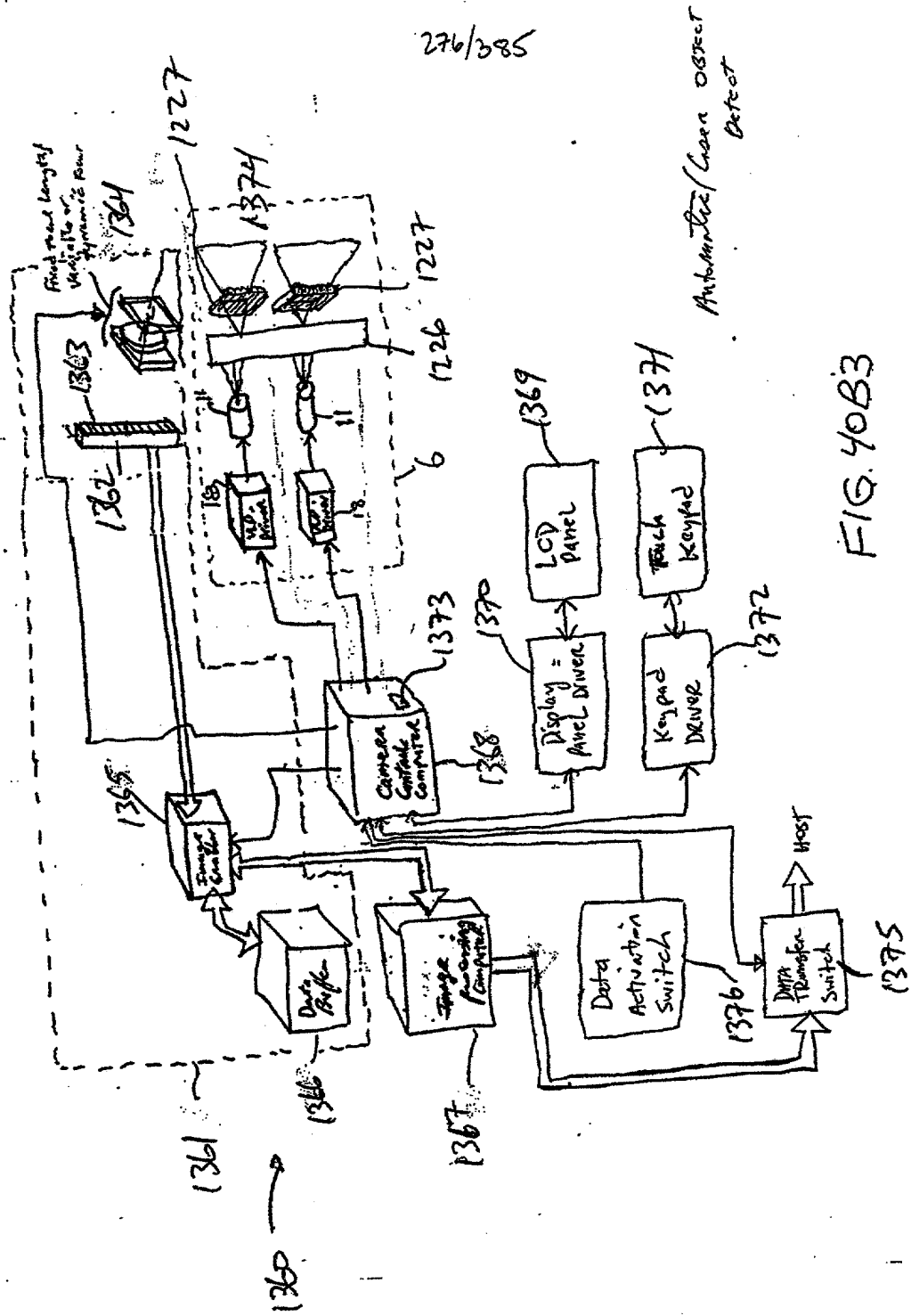


FIG. 40B2





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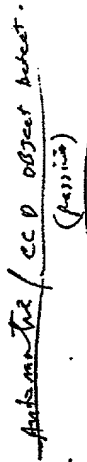
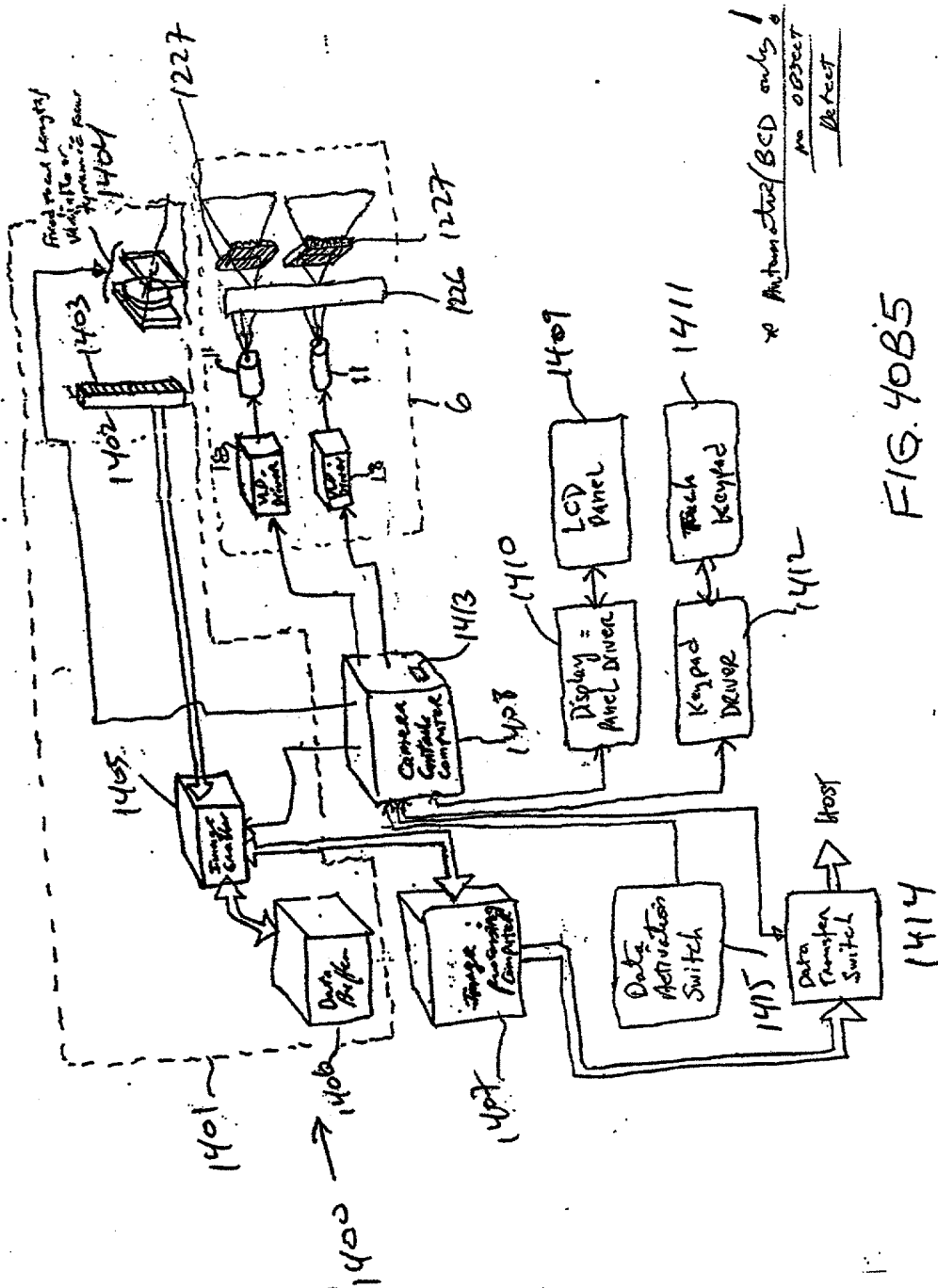


FIG. 40B.4

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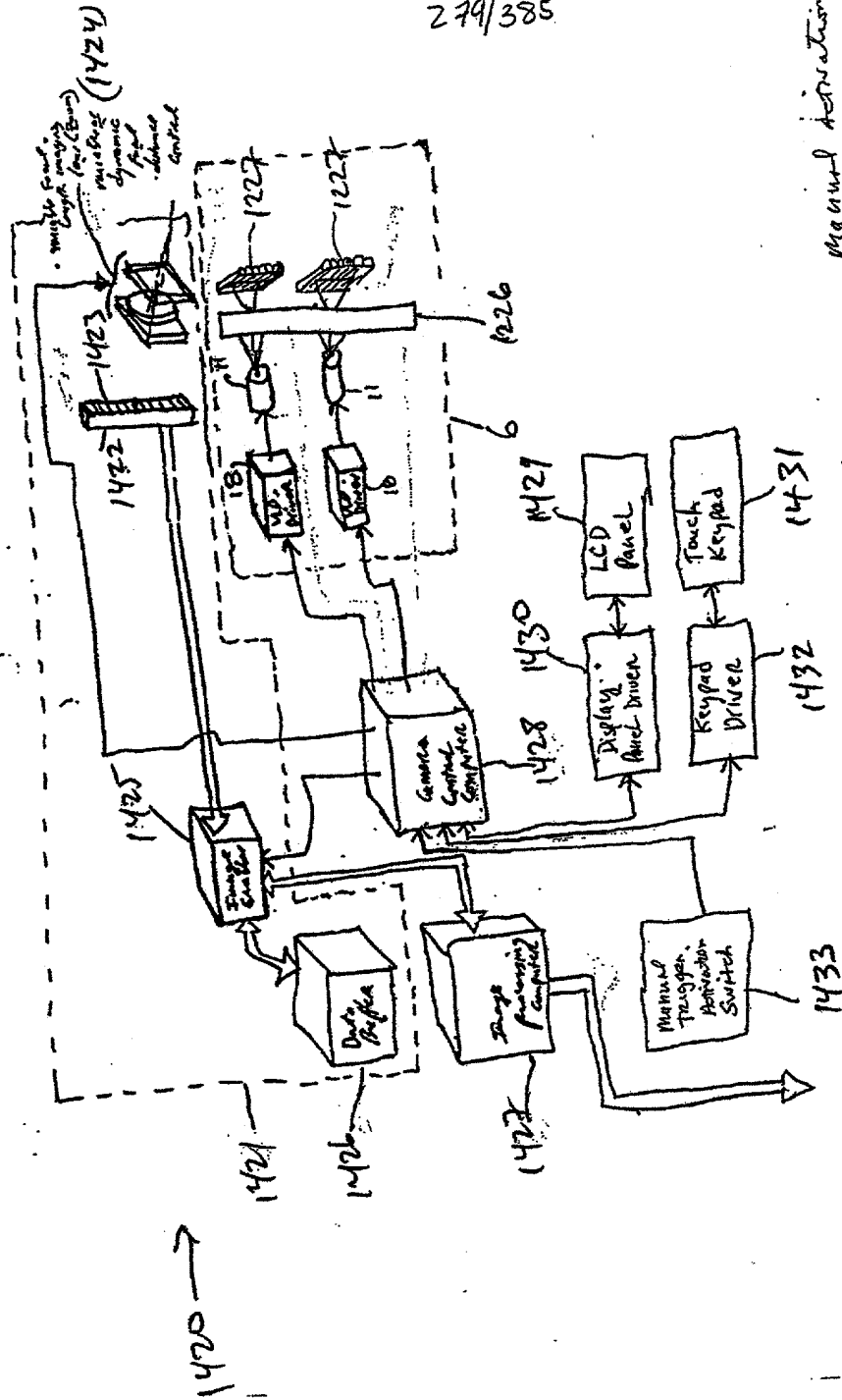
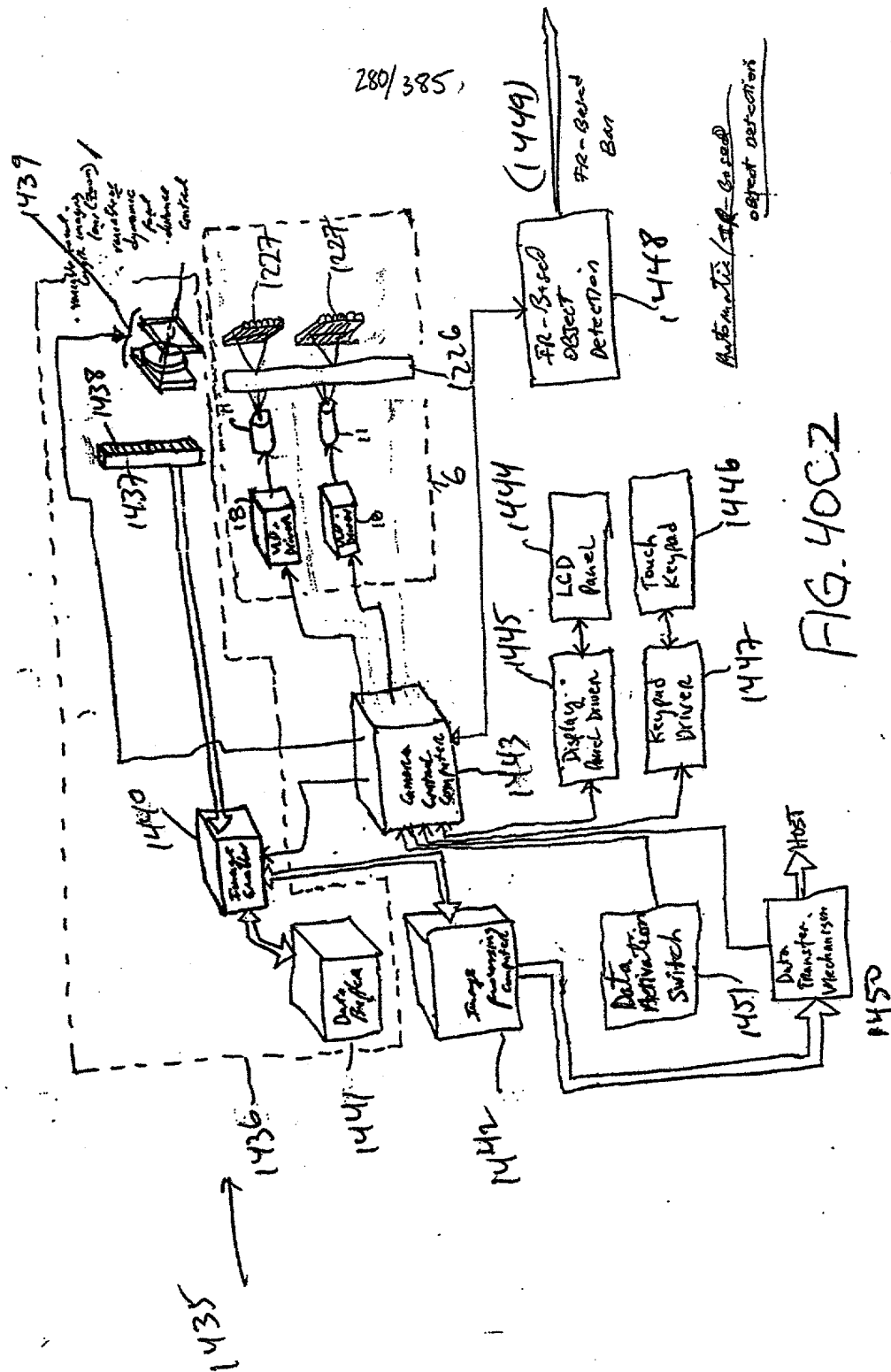
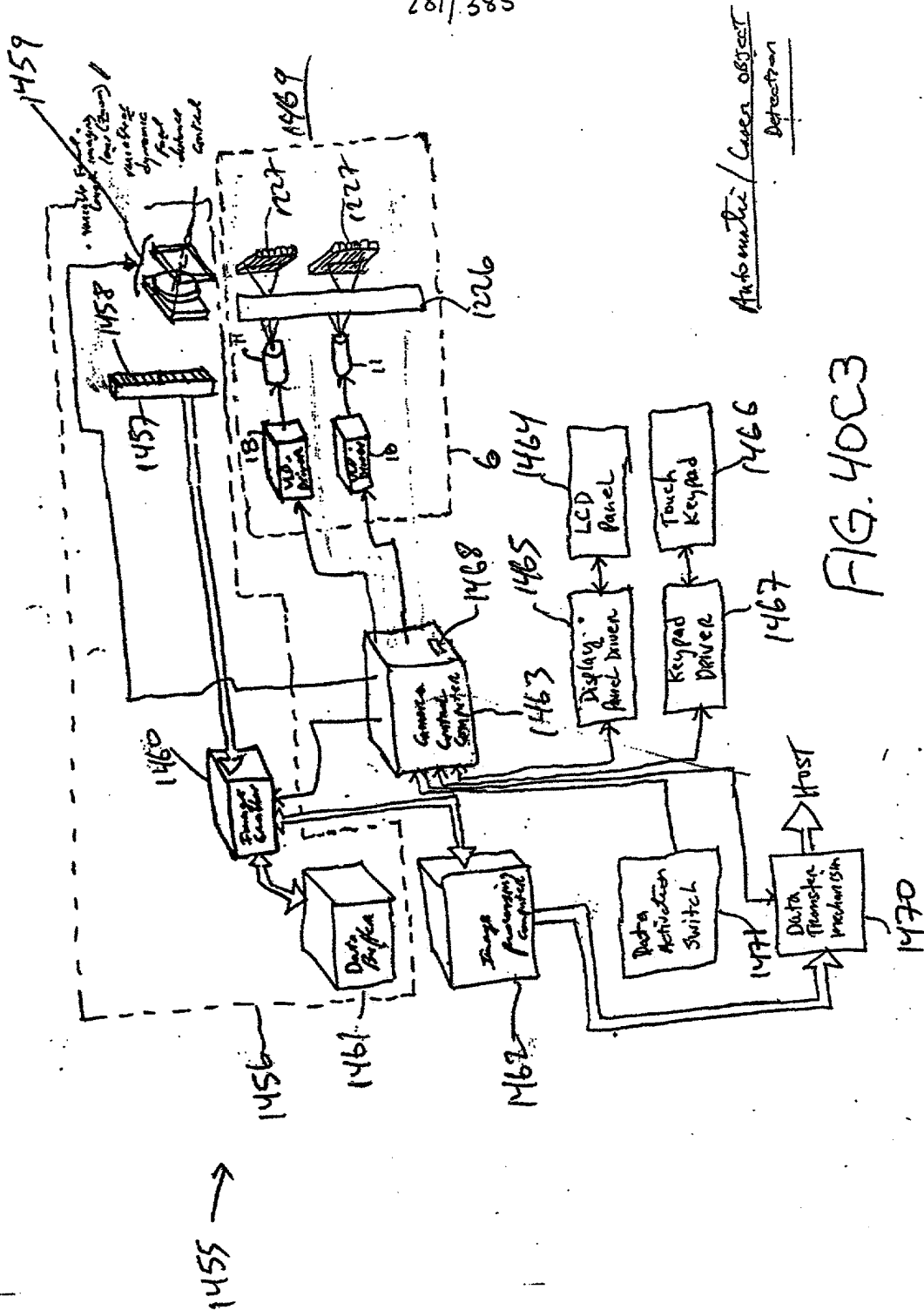


FIG. 40C1

Manual Activation

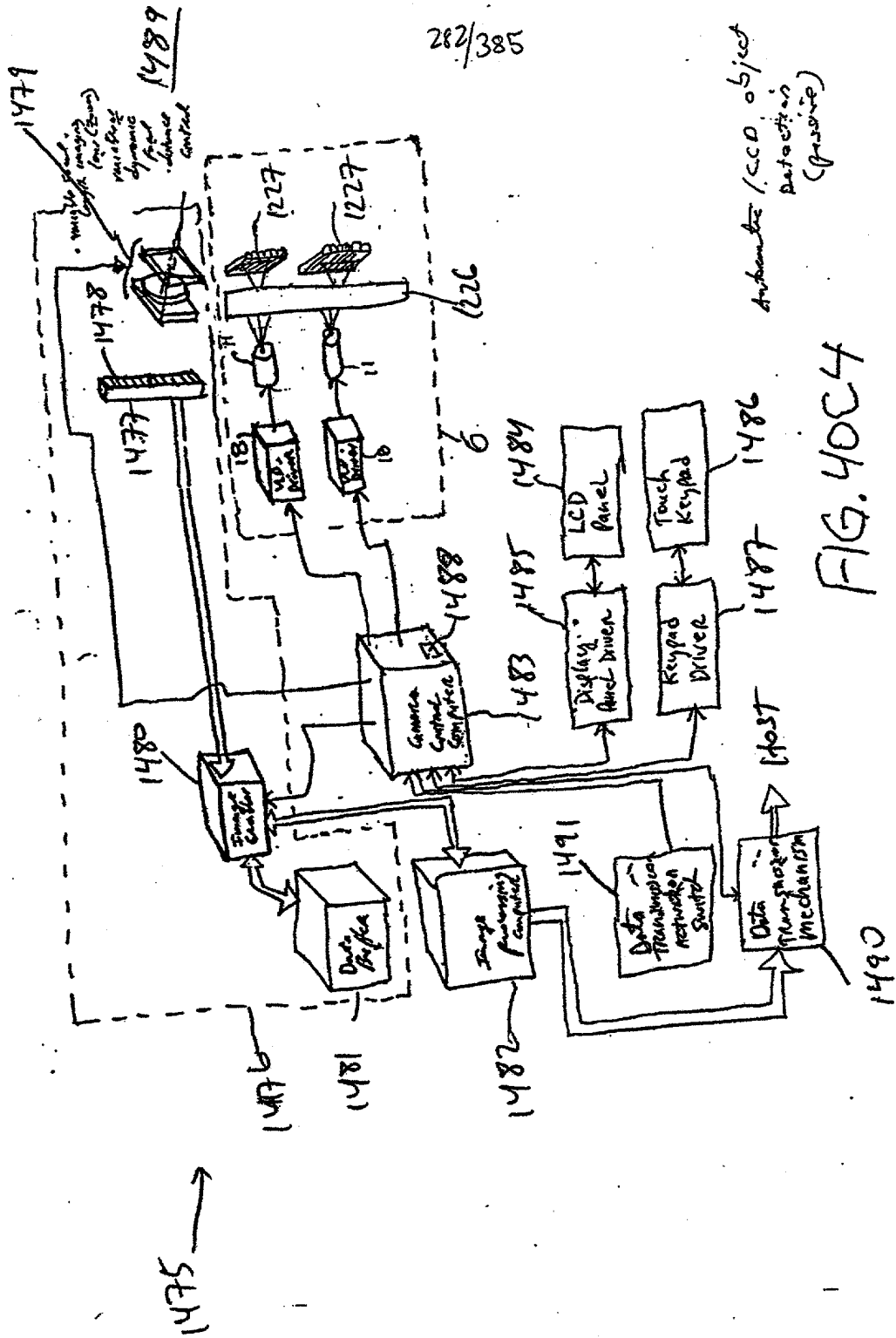


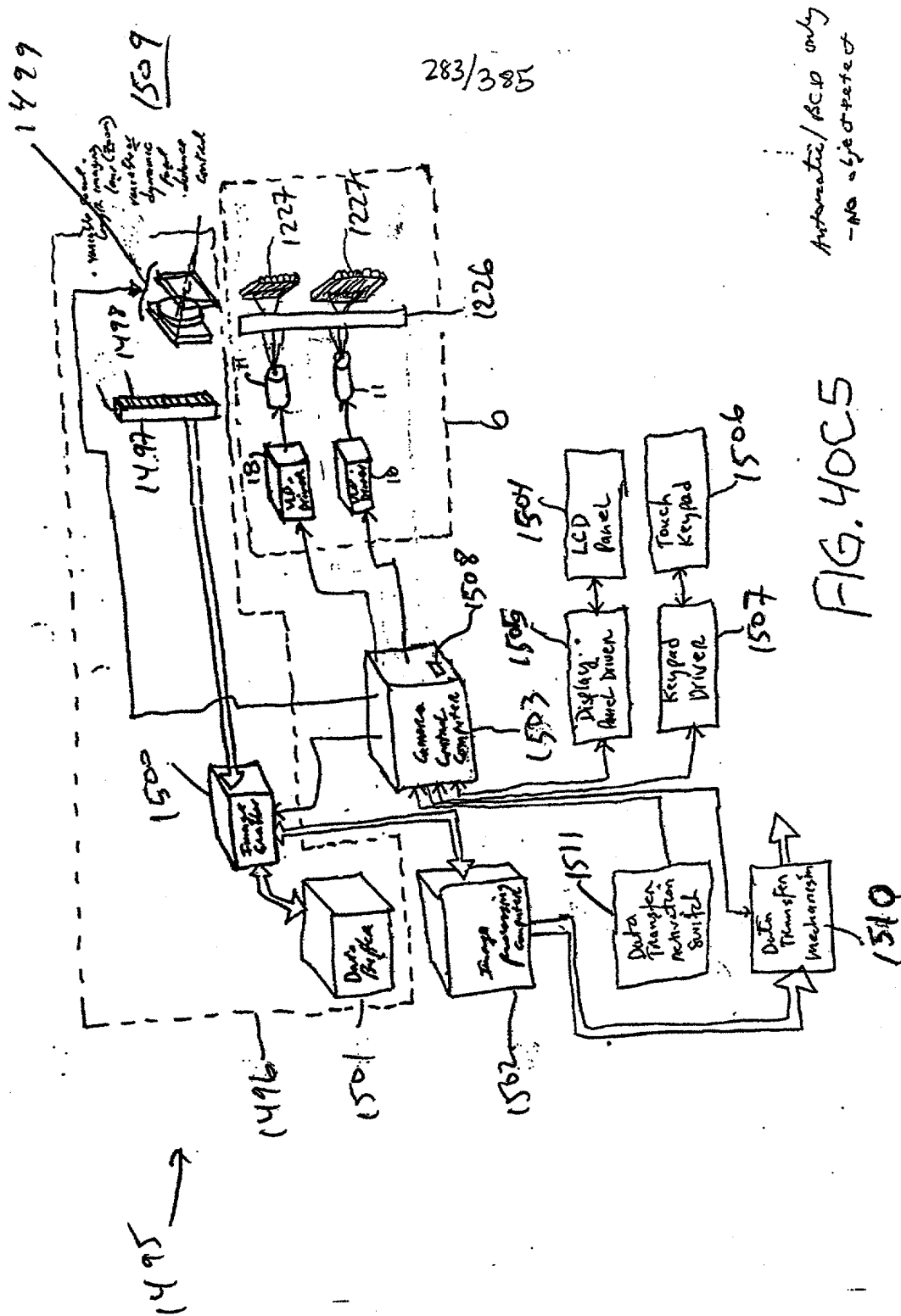


Automotive / Car object  
Detection

FIG. 40C3

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1-D  
display  
...

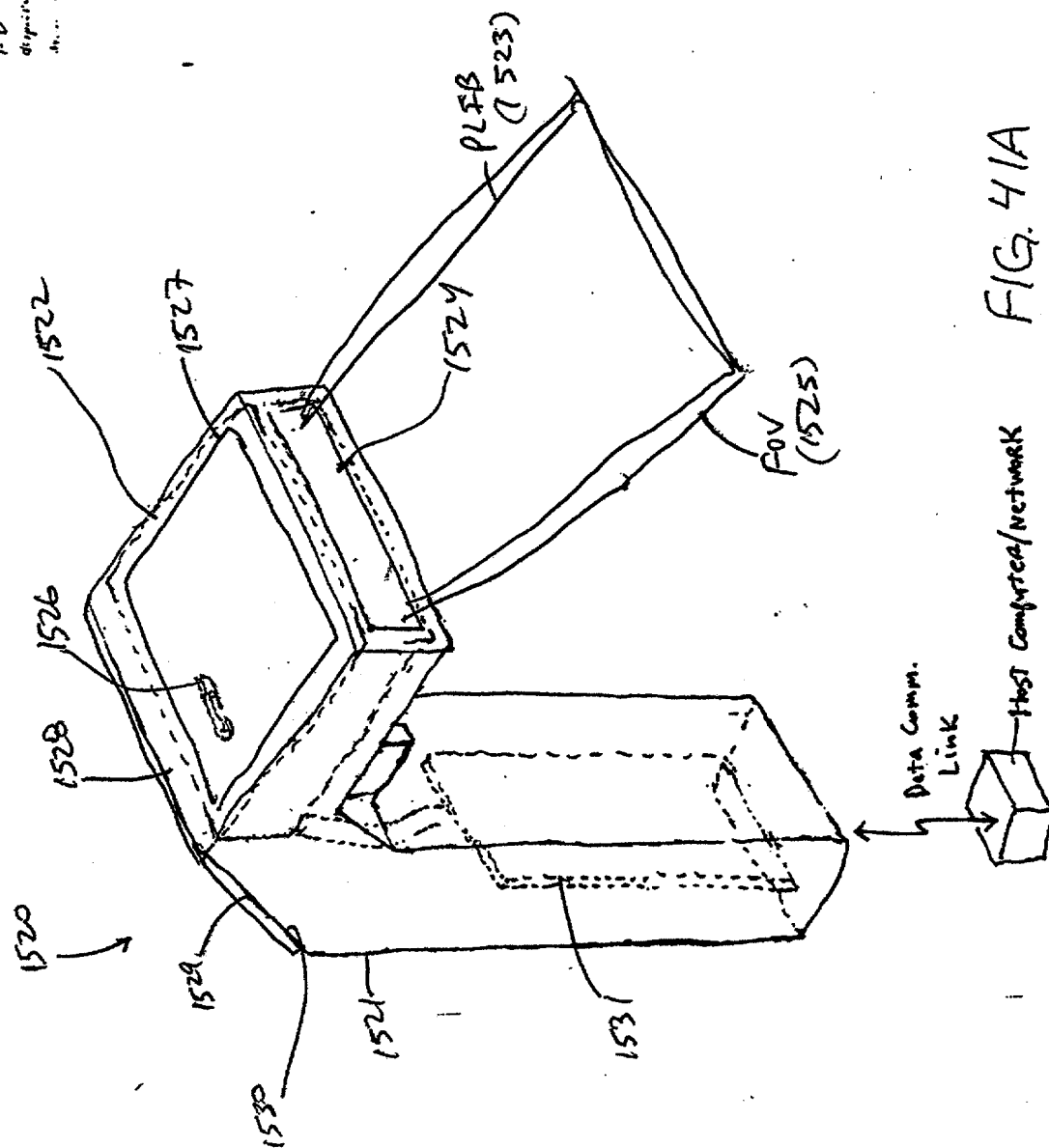


FIG. 41A



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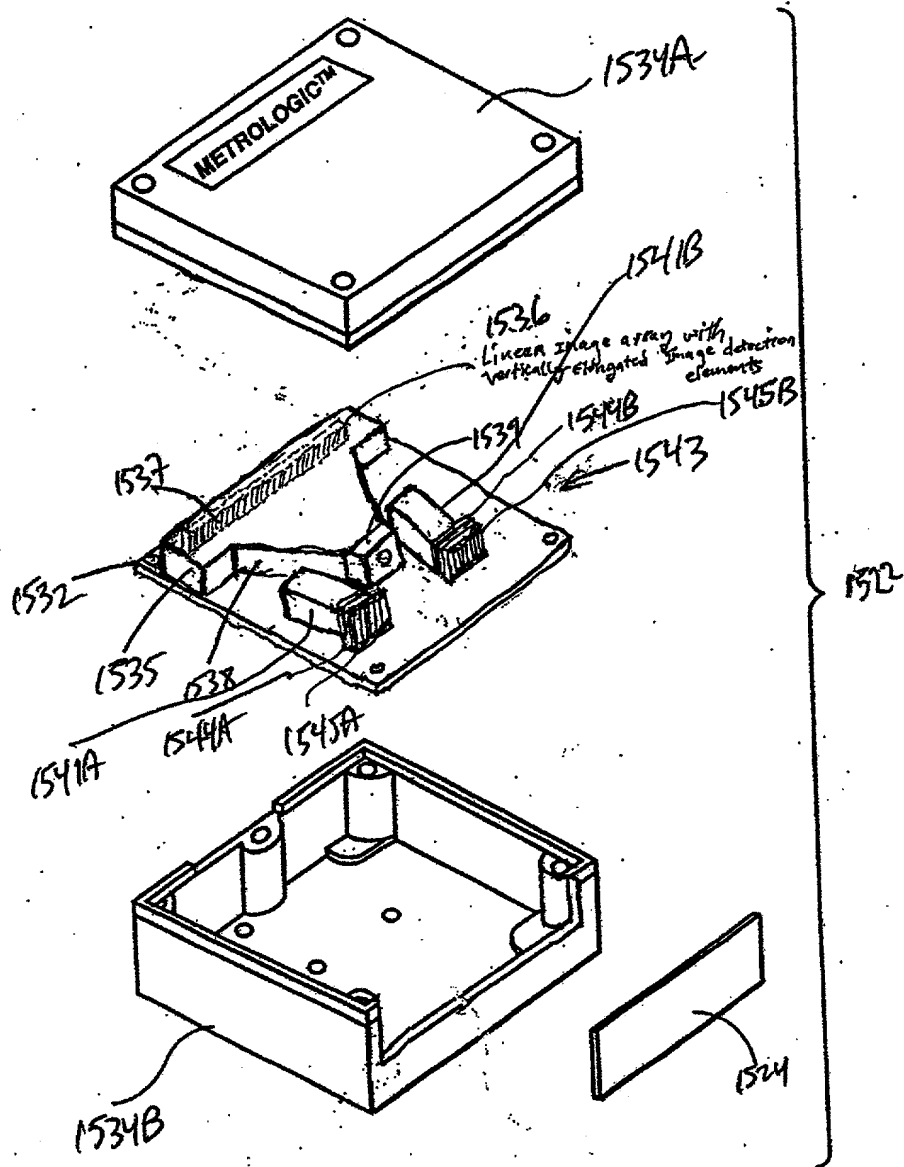


FIG. 41B

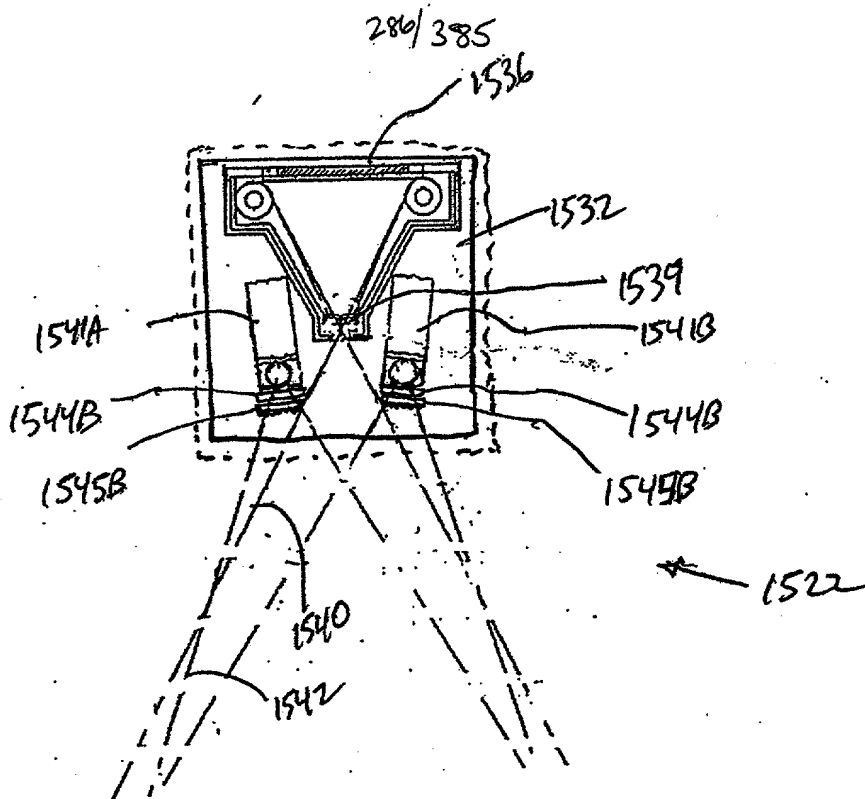


FIG. 41C

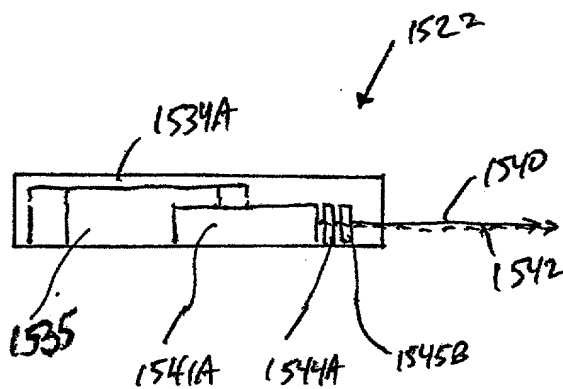
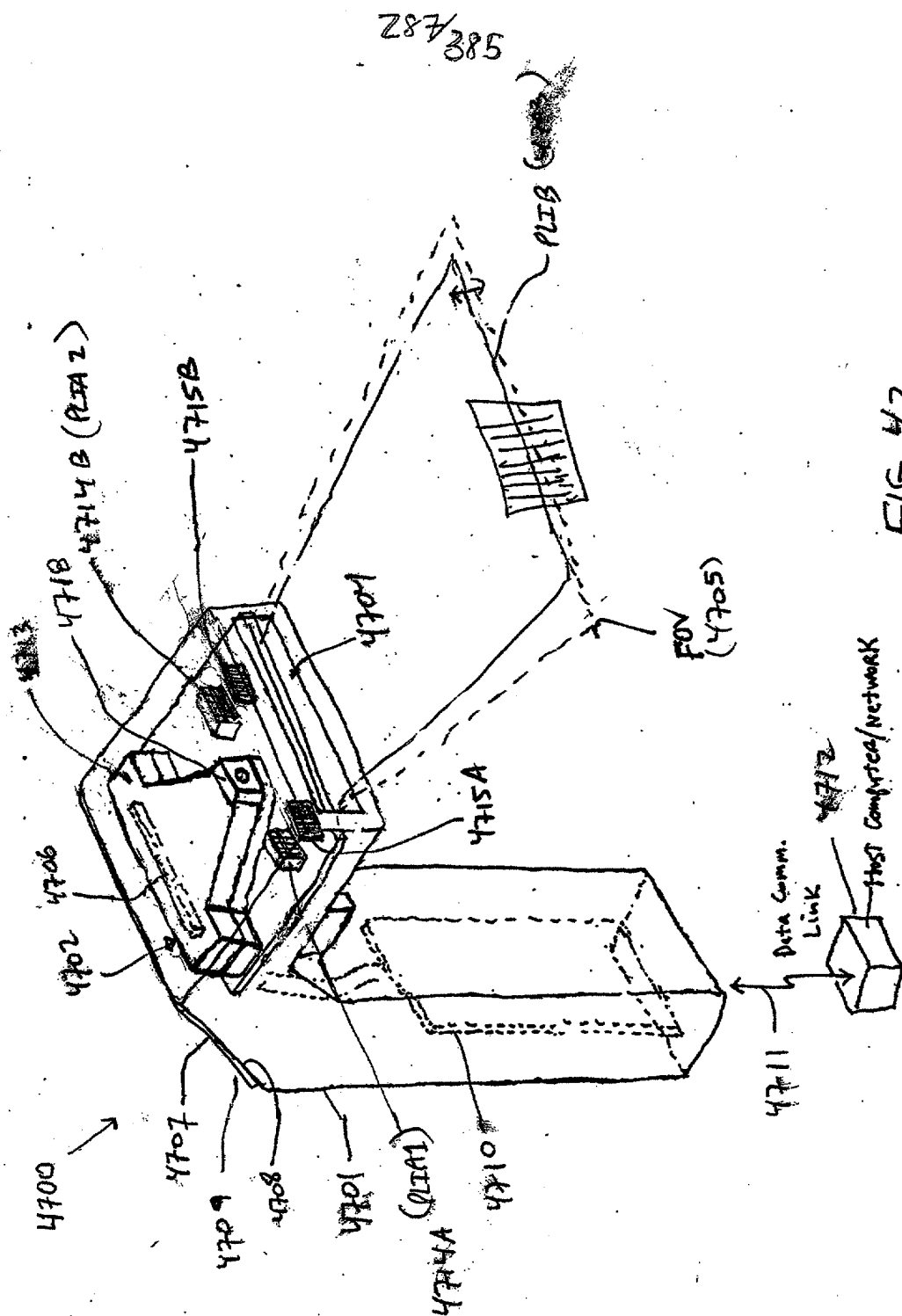


FIG. 41D



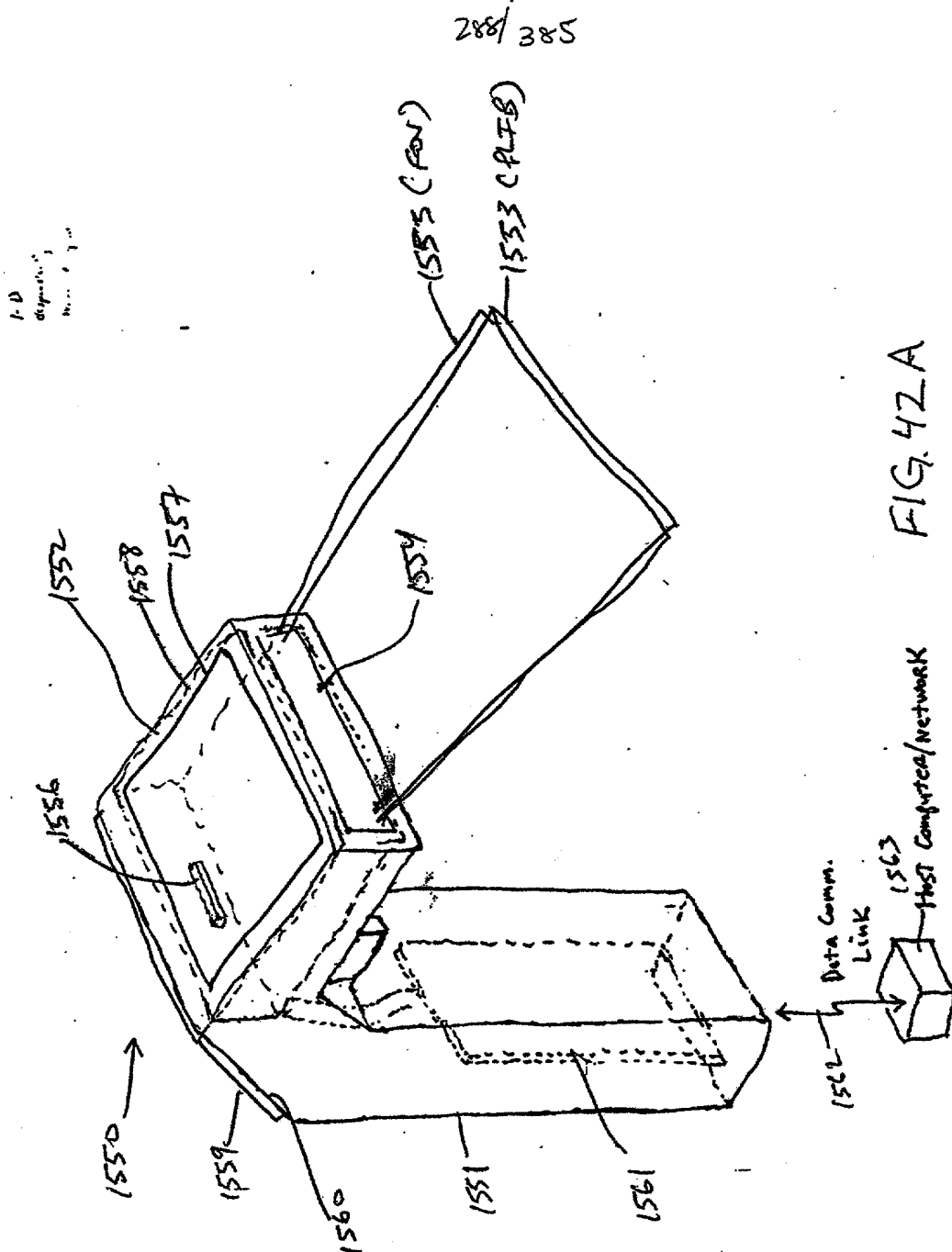


FIG. 42A

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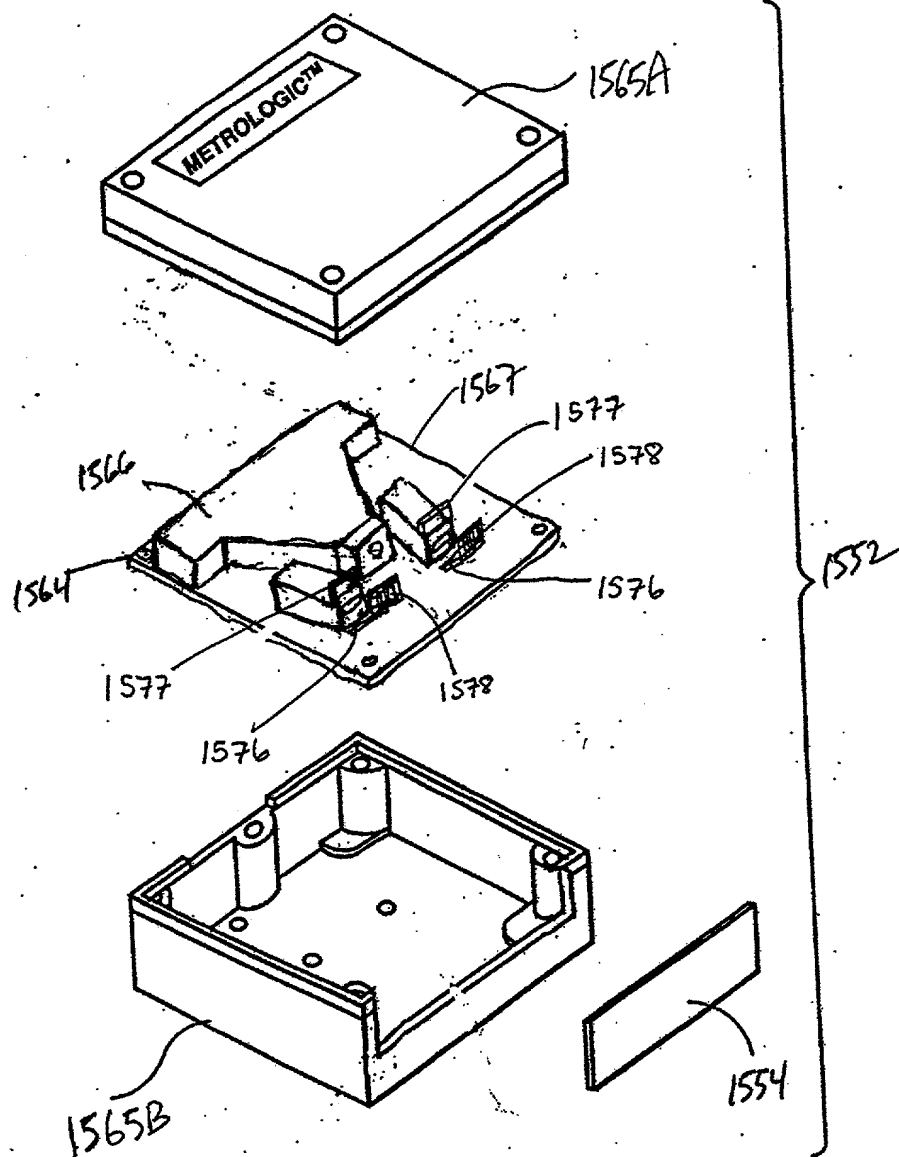


FIG. 42B

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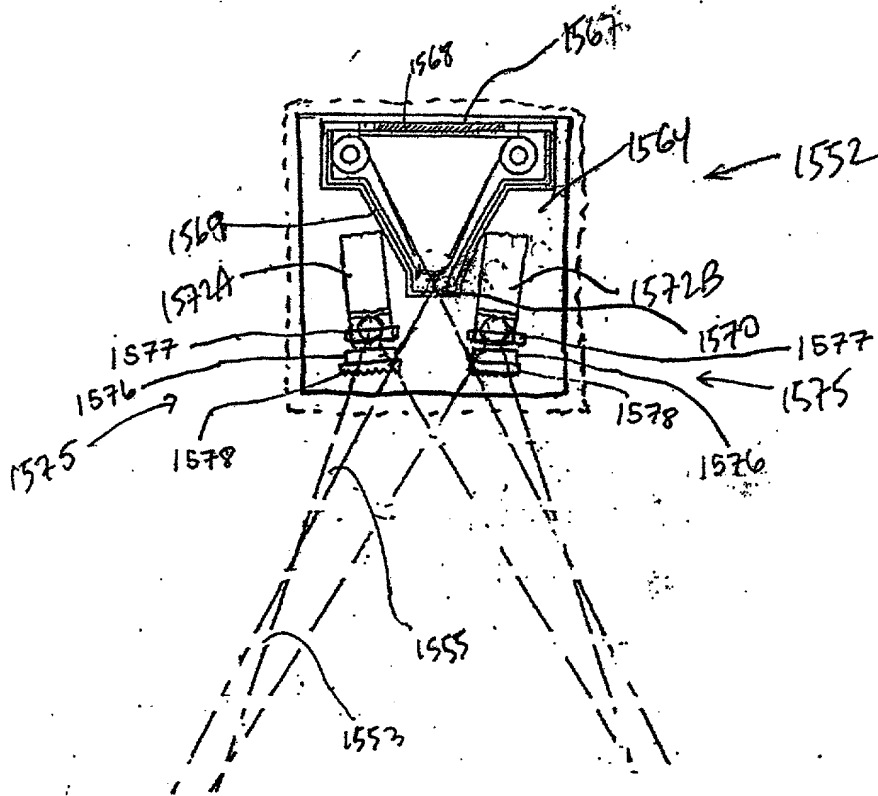


FIG. 42C

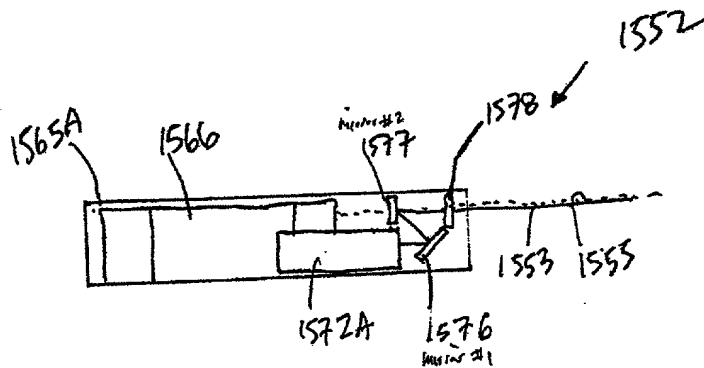


FIG. 42D

1006462.020702

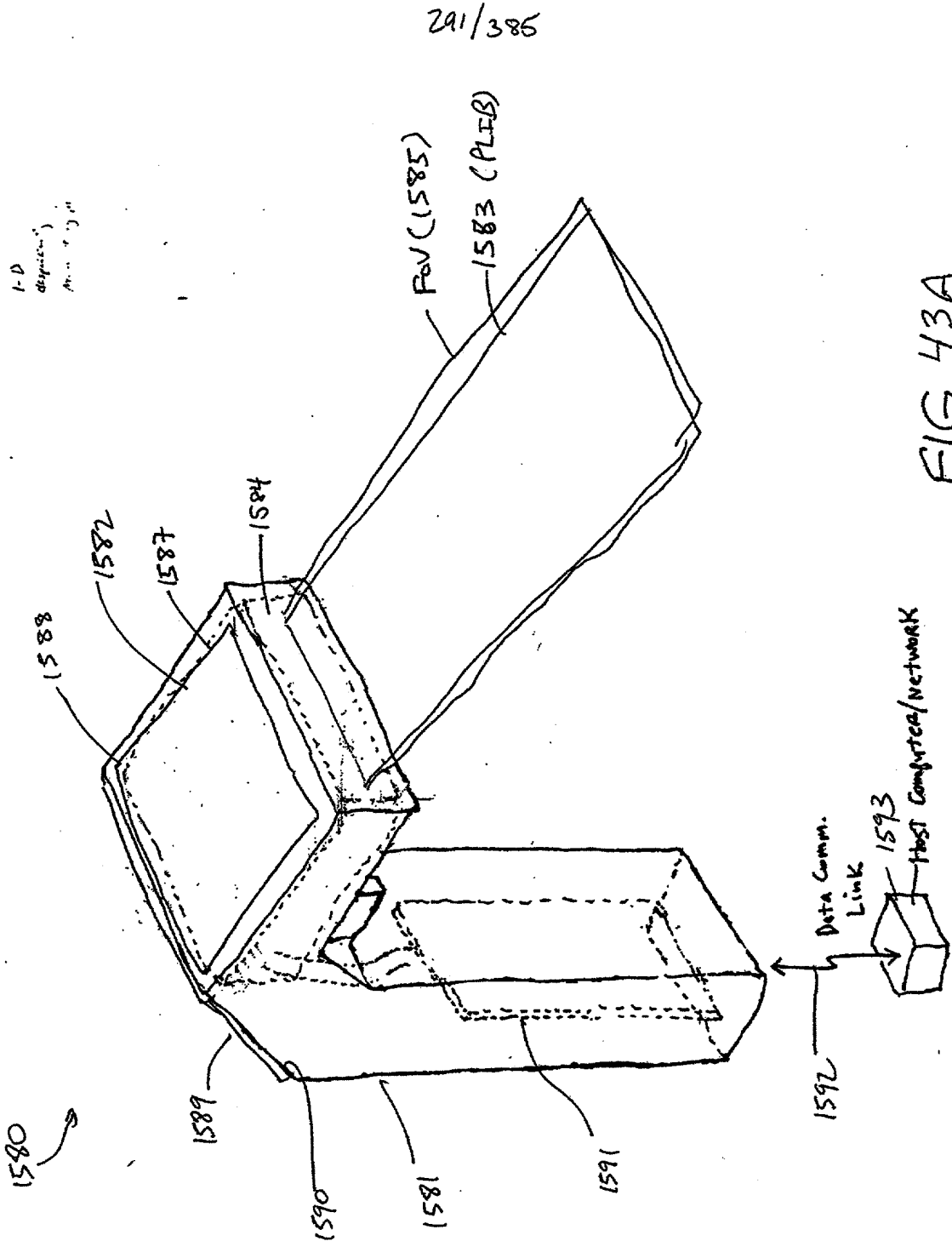


FIG. 43A

20200207.020702

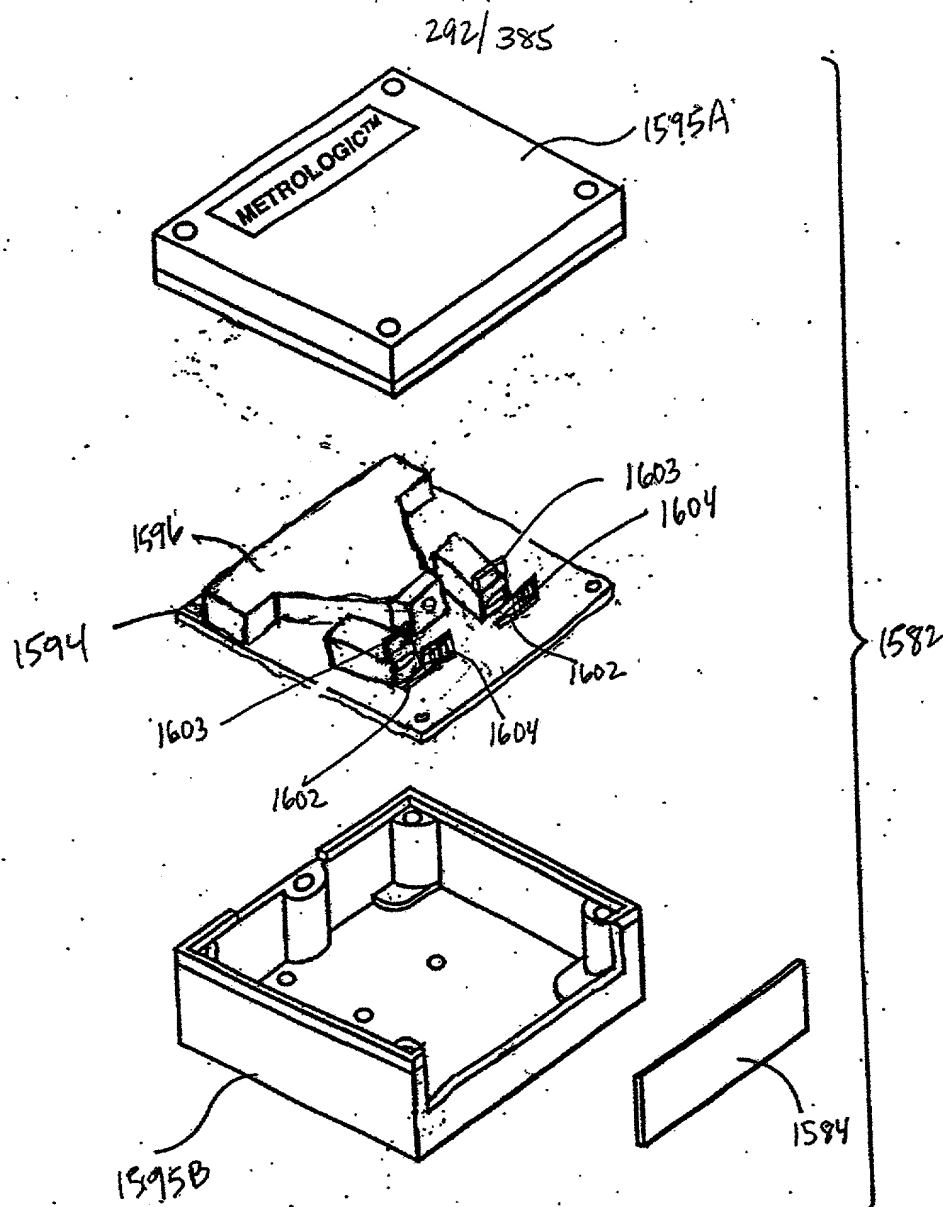


FIG. 43B



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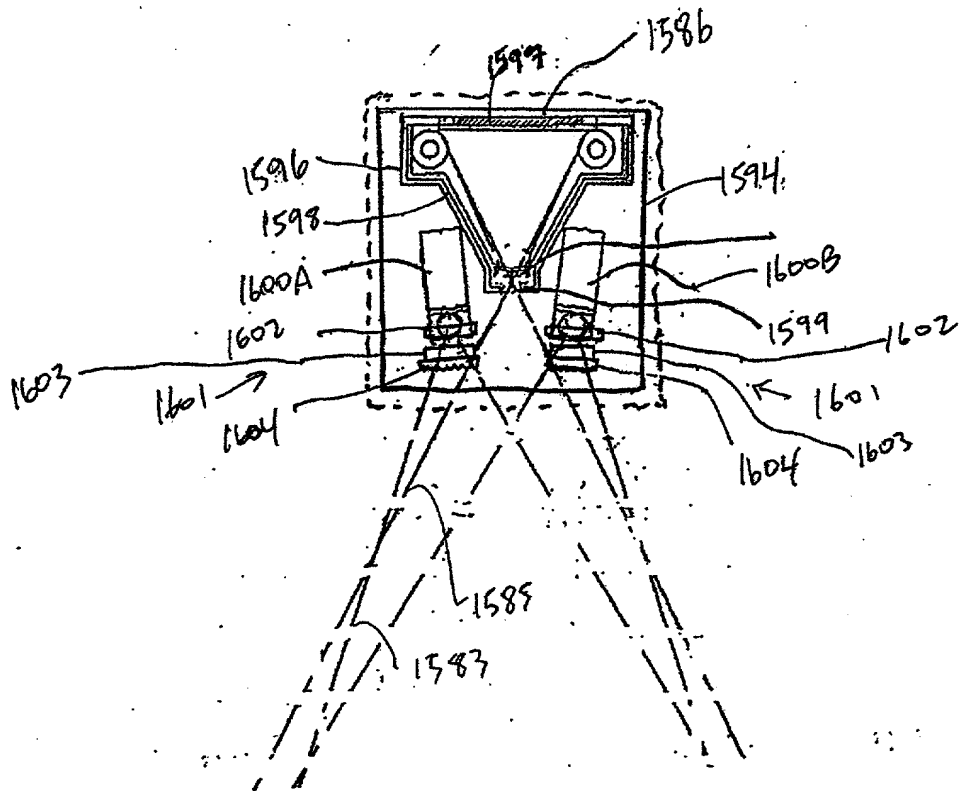


FIG. 43C

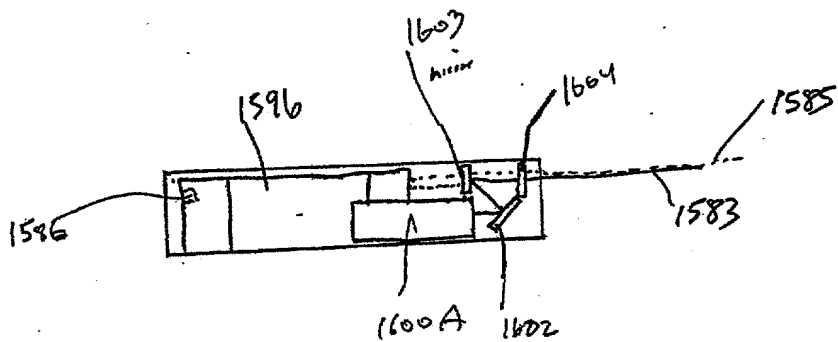
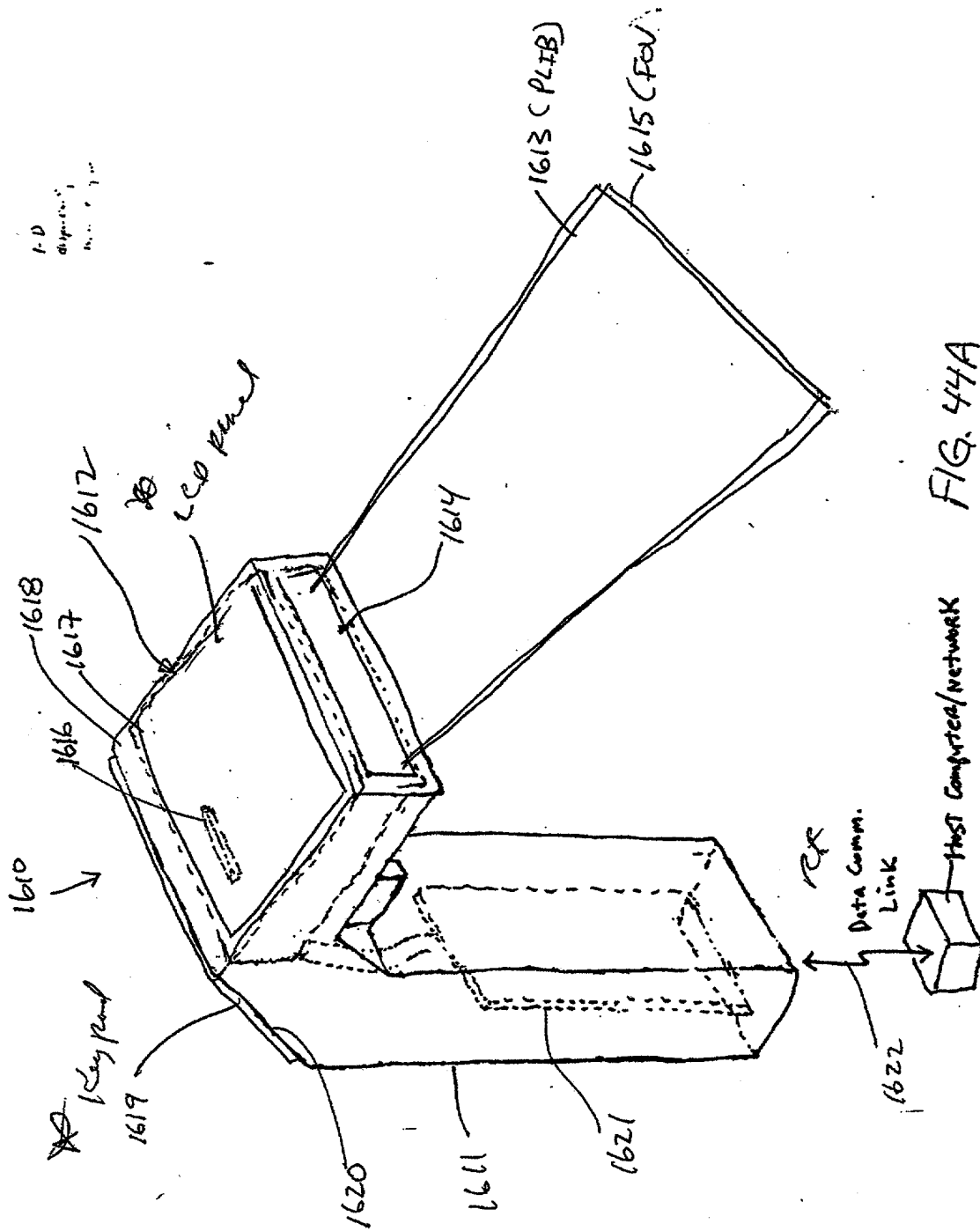


FIG. 43D

202020-29489001



10068462.020702

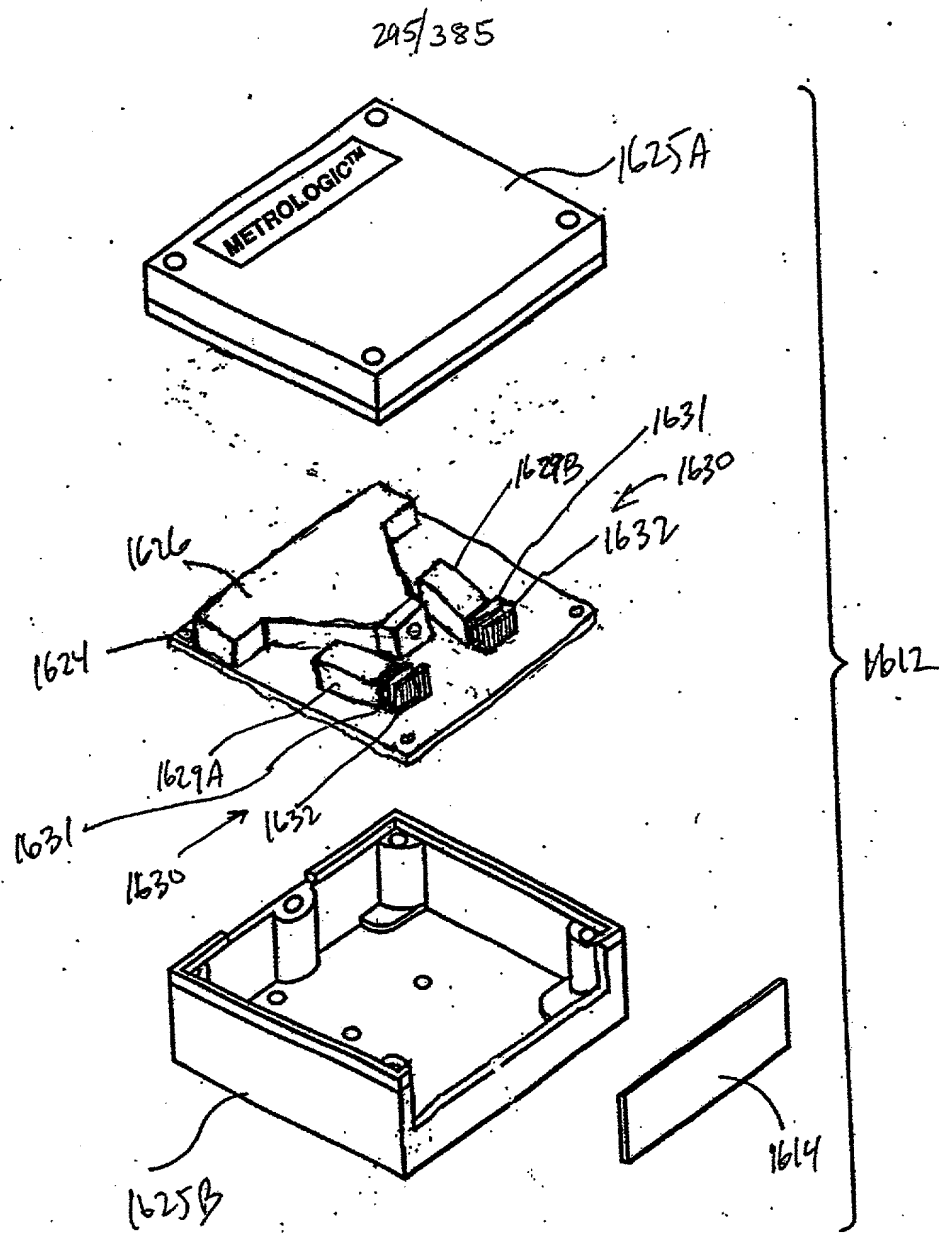


FIG. 44B

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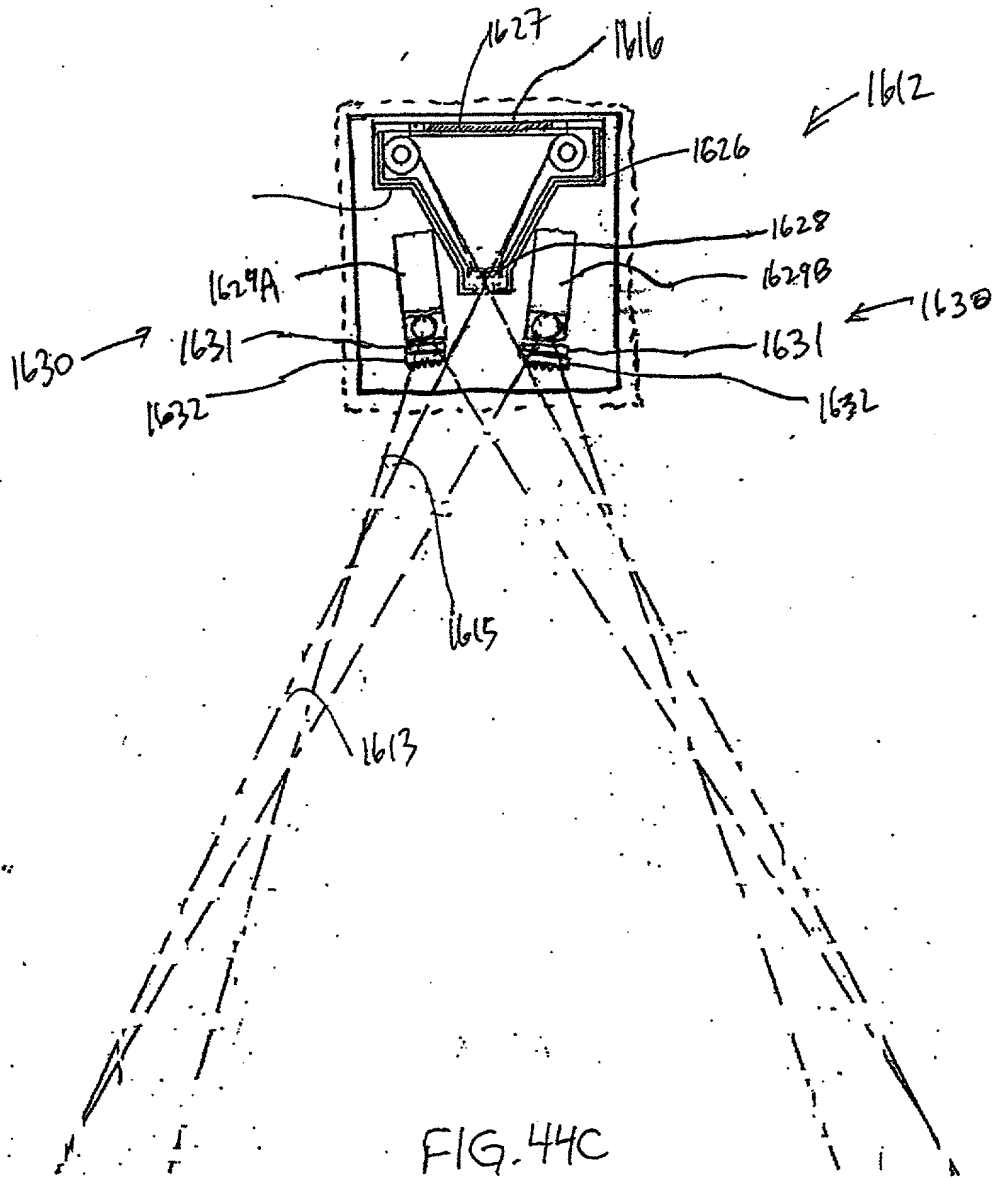


FIG. 44C

10058462.020702

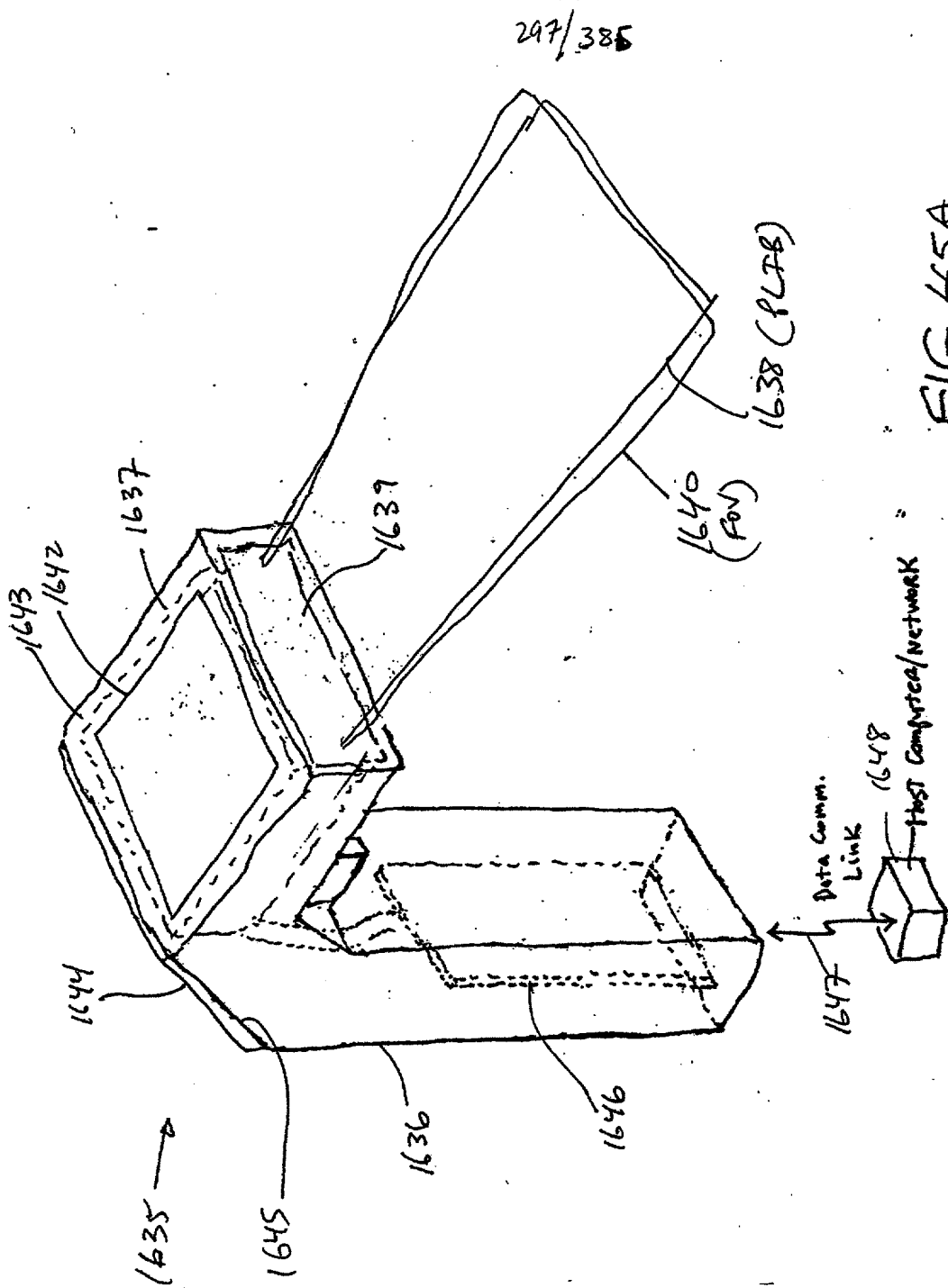


FIG. 45A

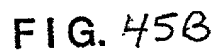


FIG. 45B

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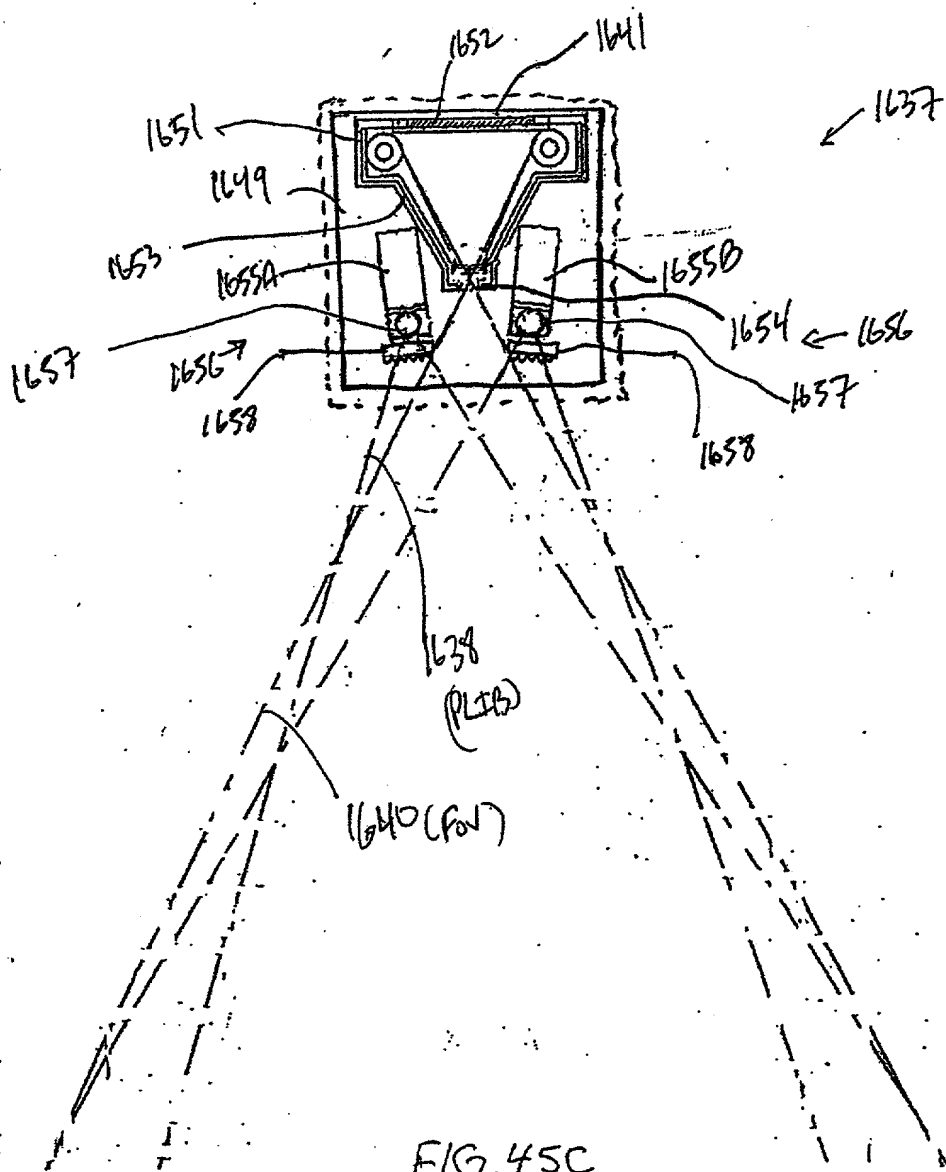
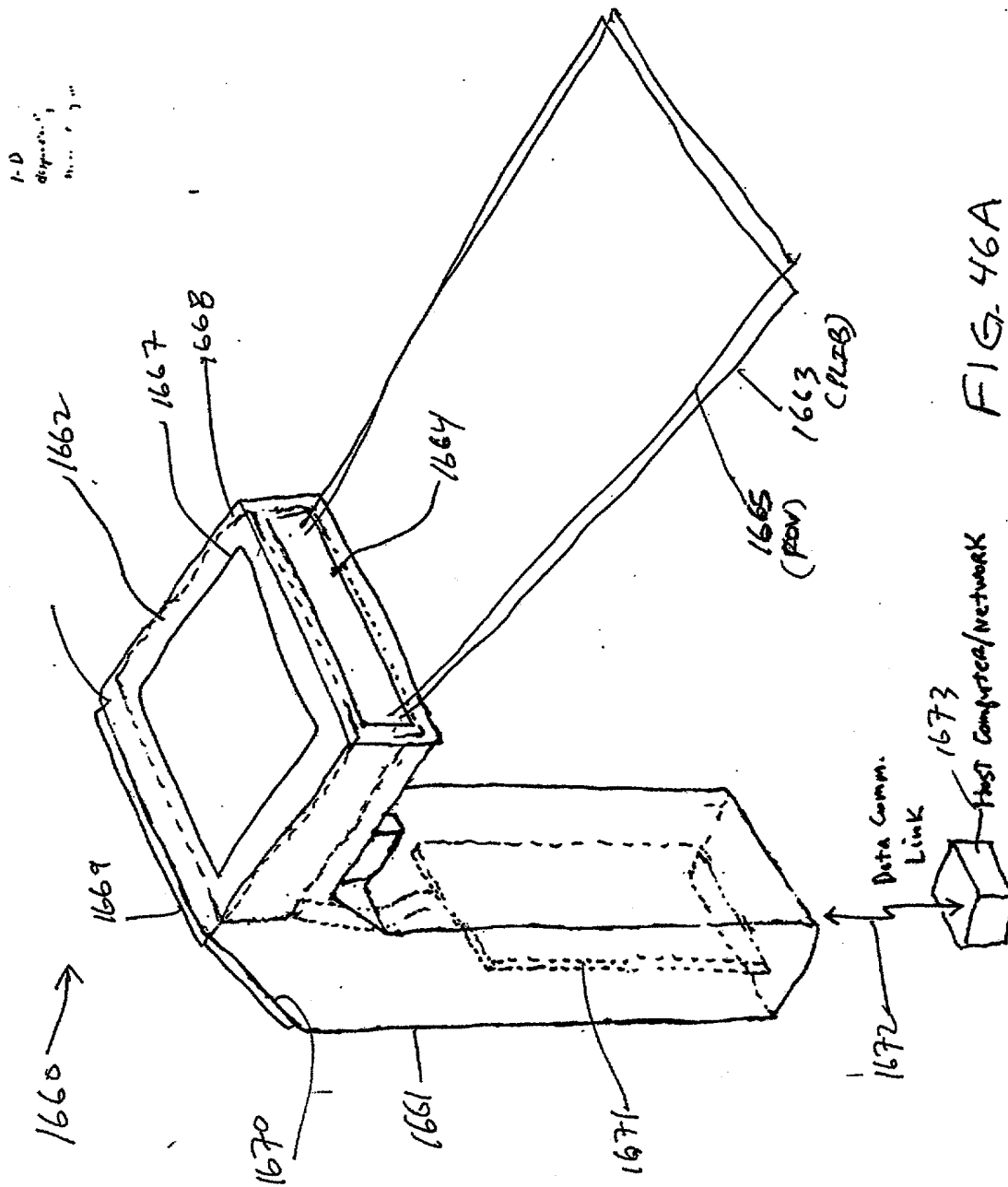


FIG. 45C

10058462-020702





2006462.020702

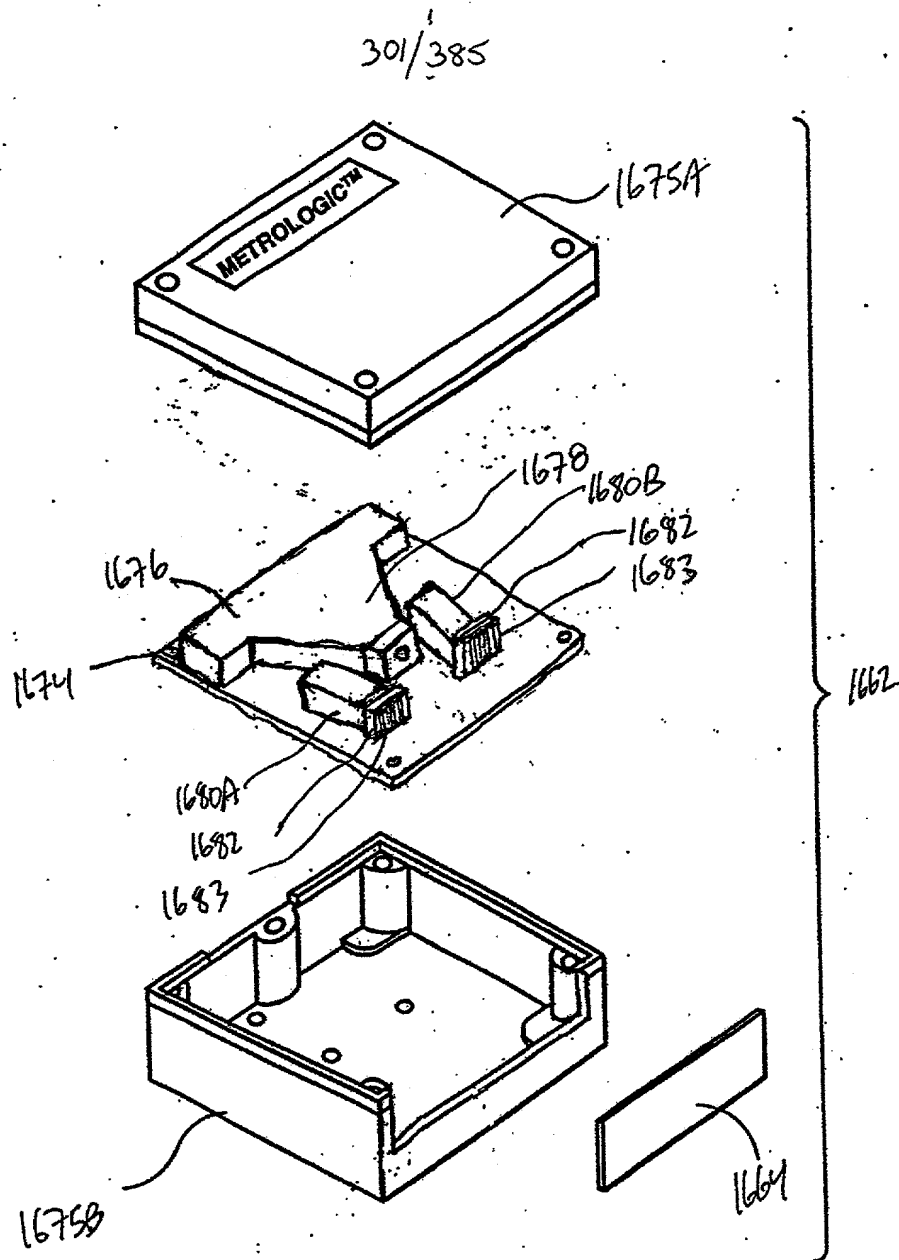
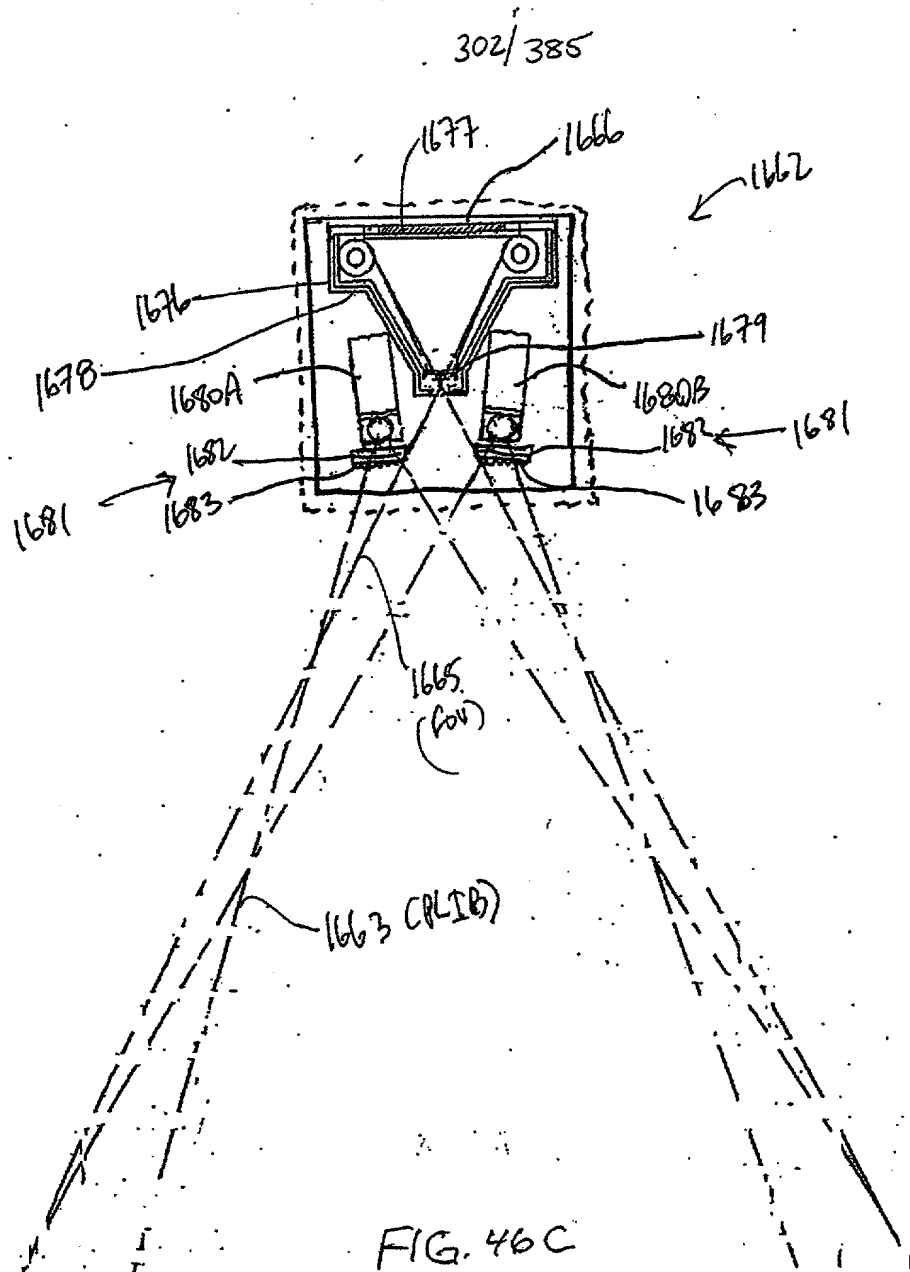


FIG. 46B

**THE UNIVERSITY OF CHICAGO**



10058462.020702

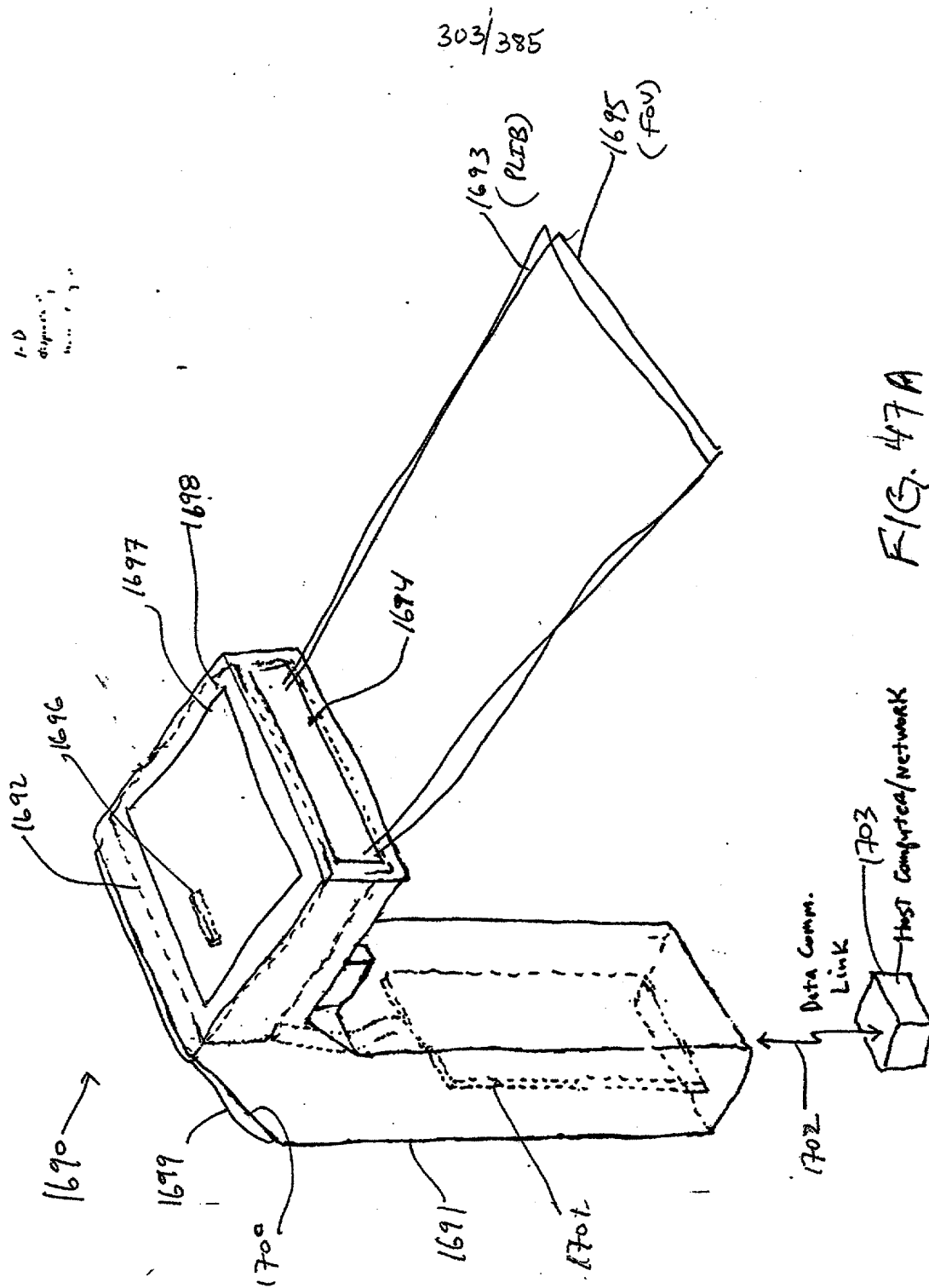


FIG. 47A

10068462-020702

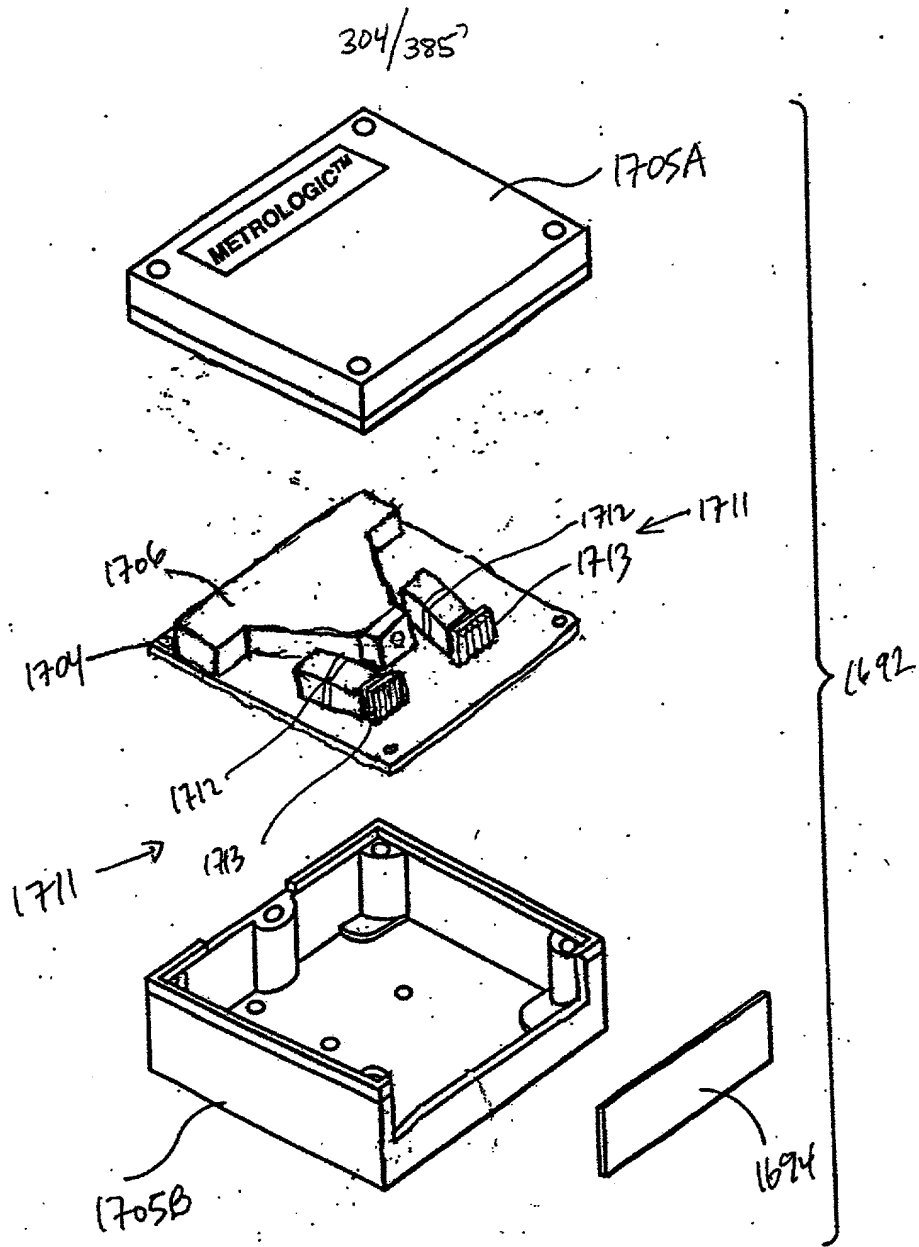
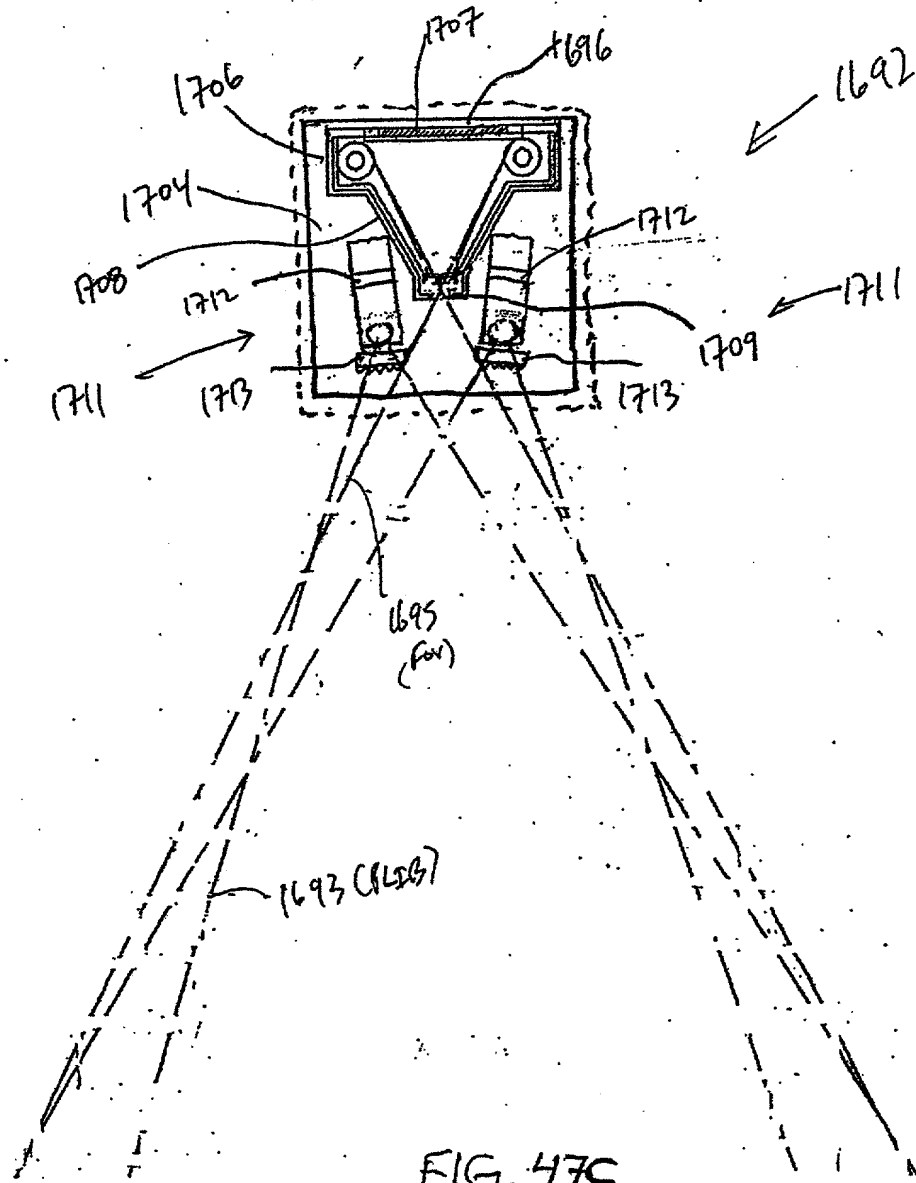


FIG. 47B

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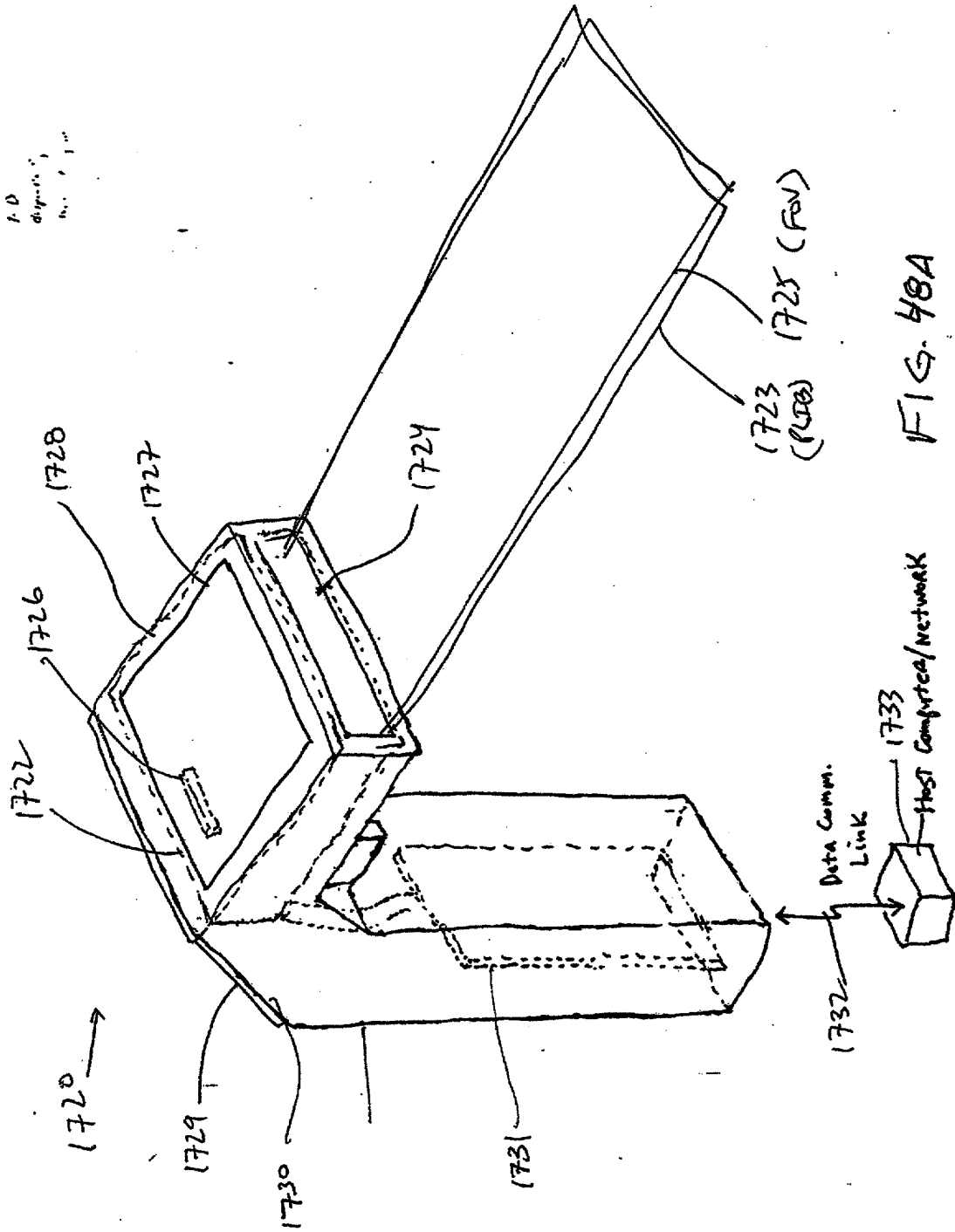


FIG. 48A

202020 29489001

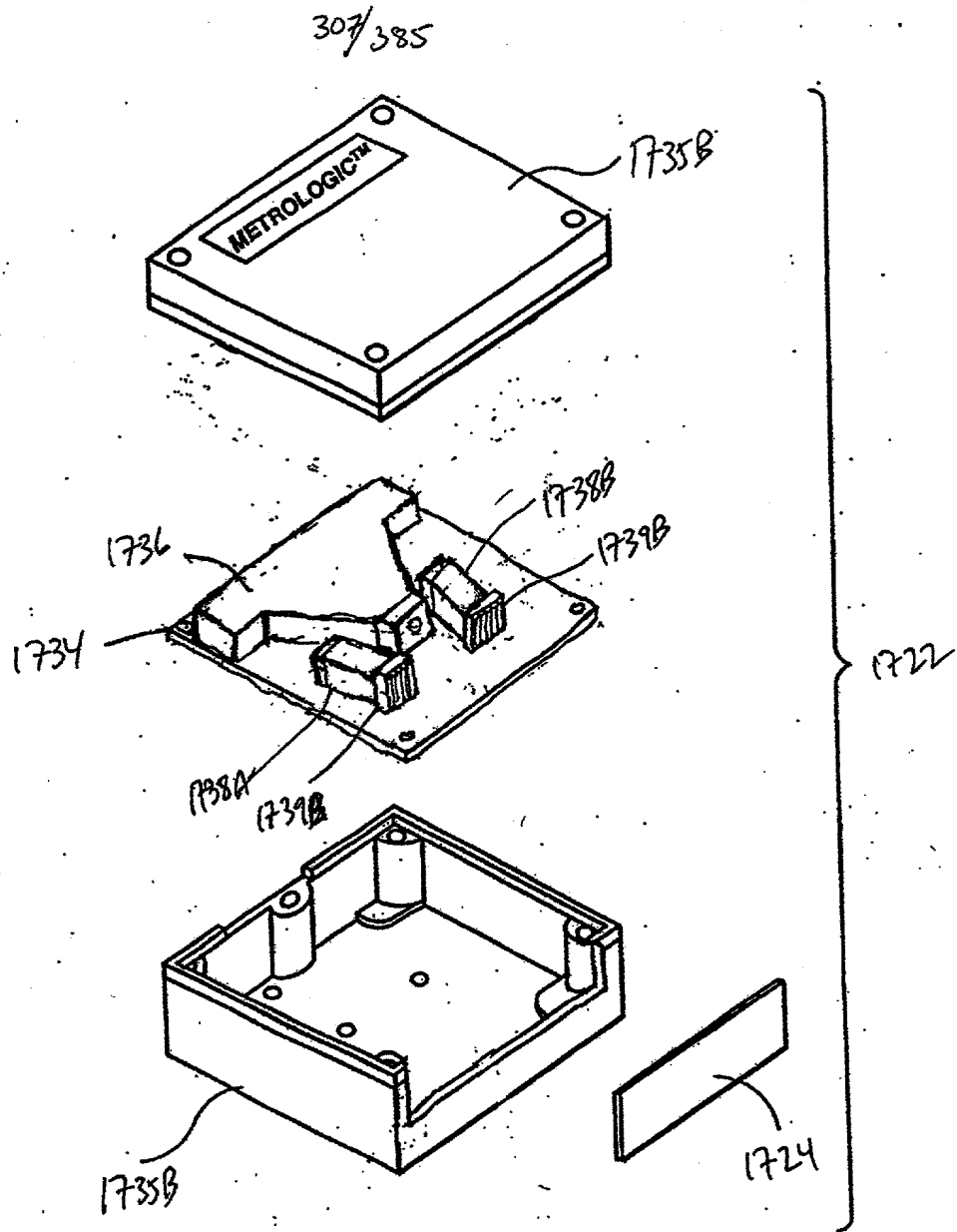


FIG. 48B

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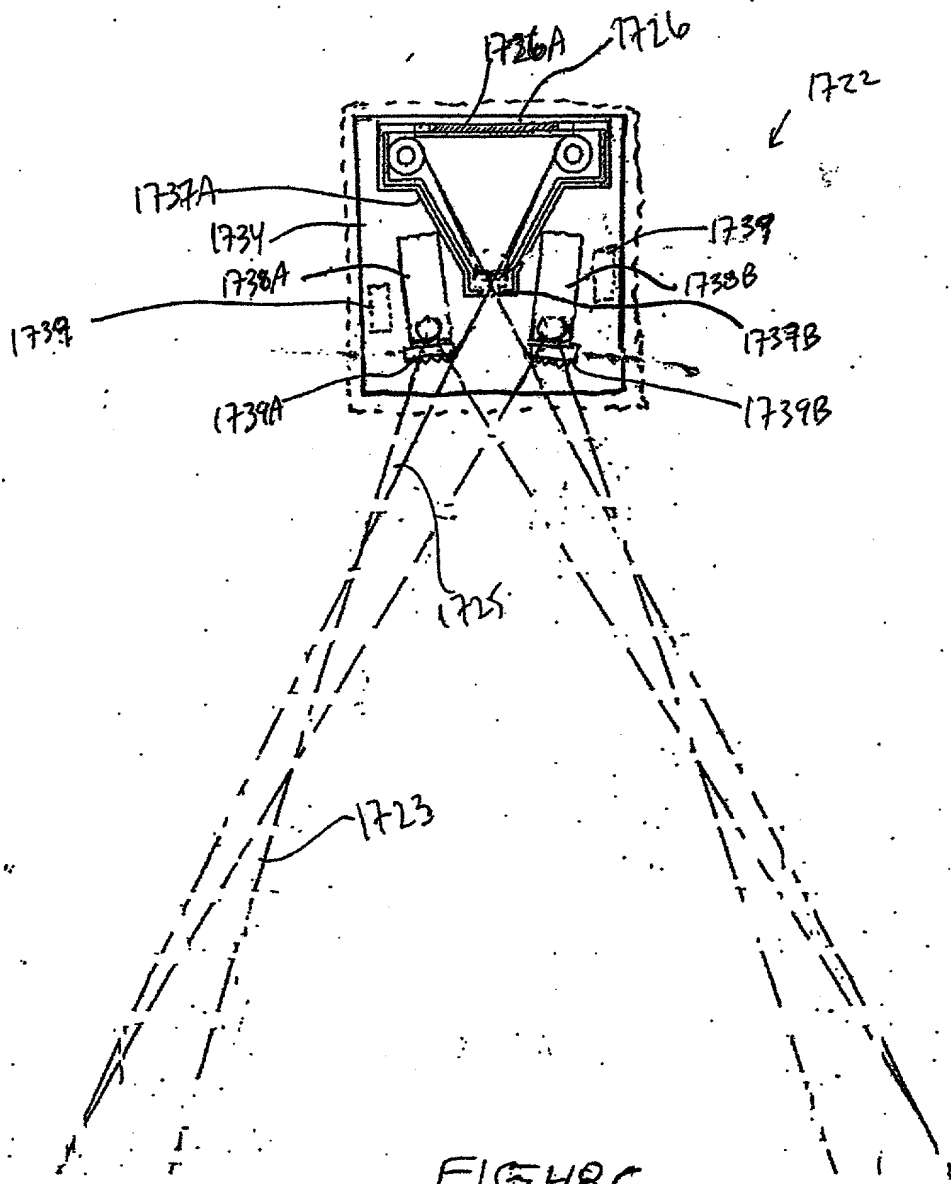


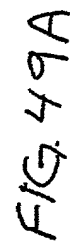
FIG. 48C

10068463.020702



4

!



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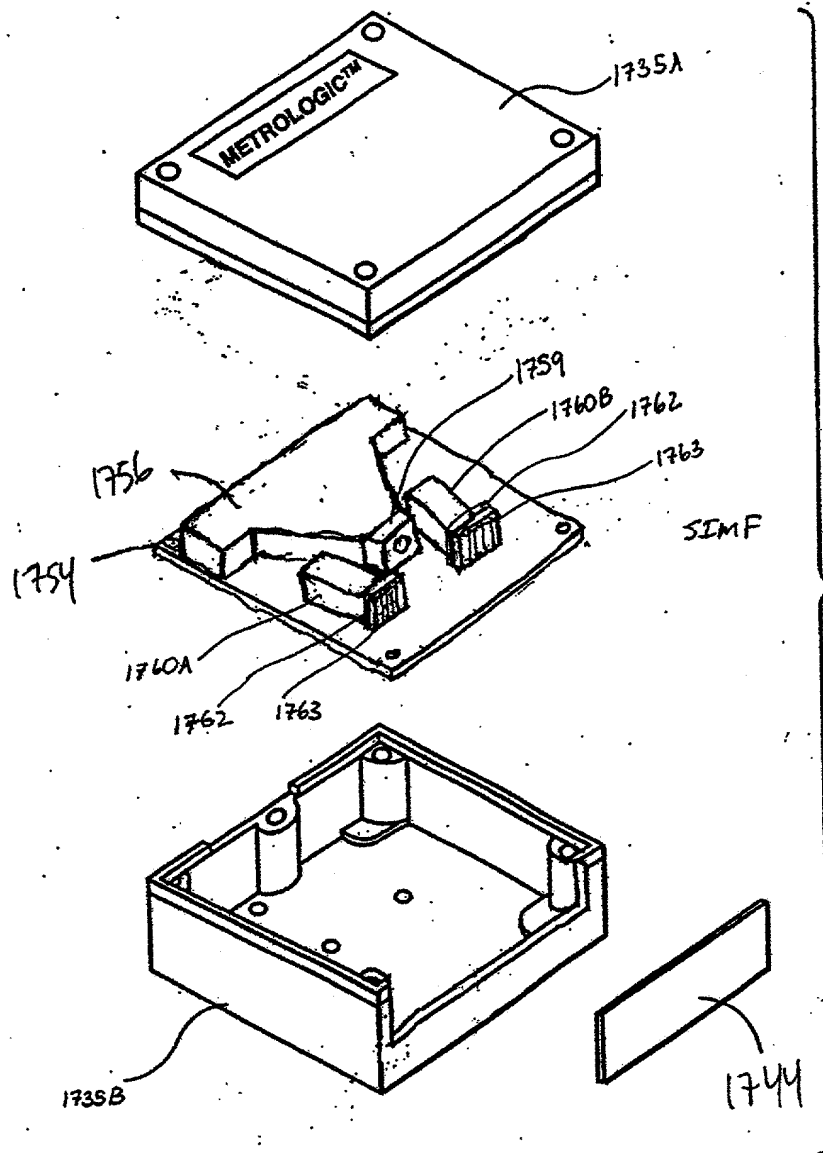


FIG. 49B

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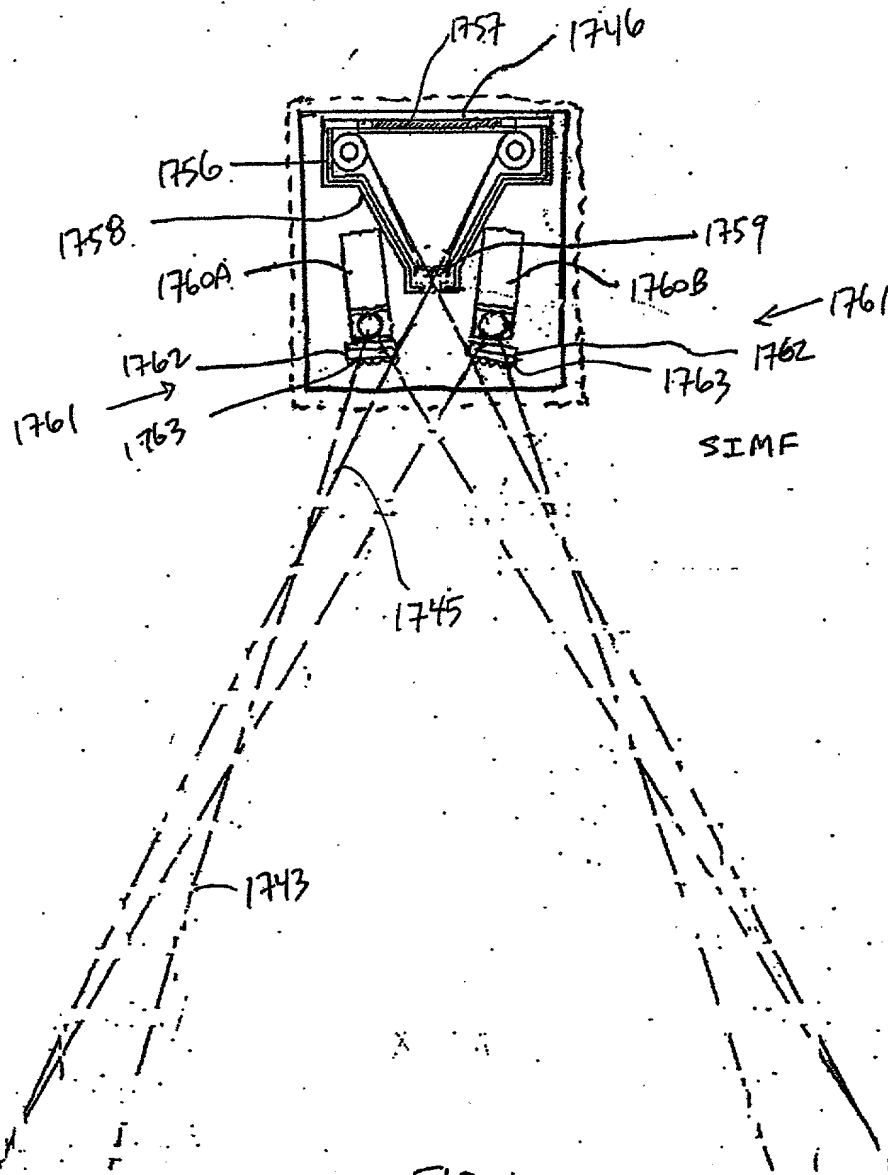
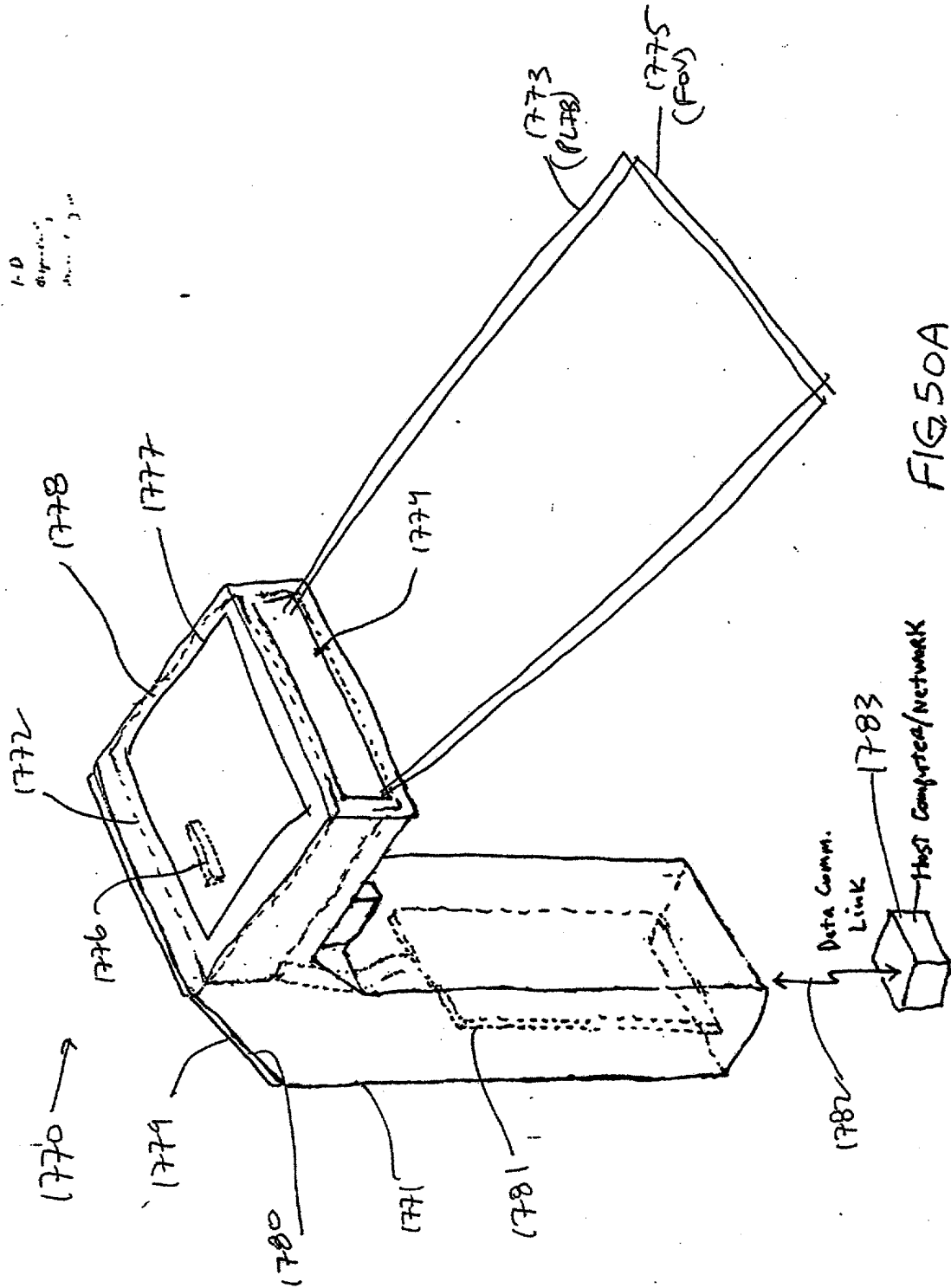


FIG. 49C

1068462.020702

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20202029489001

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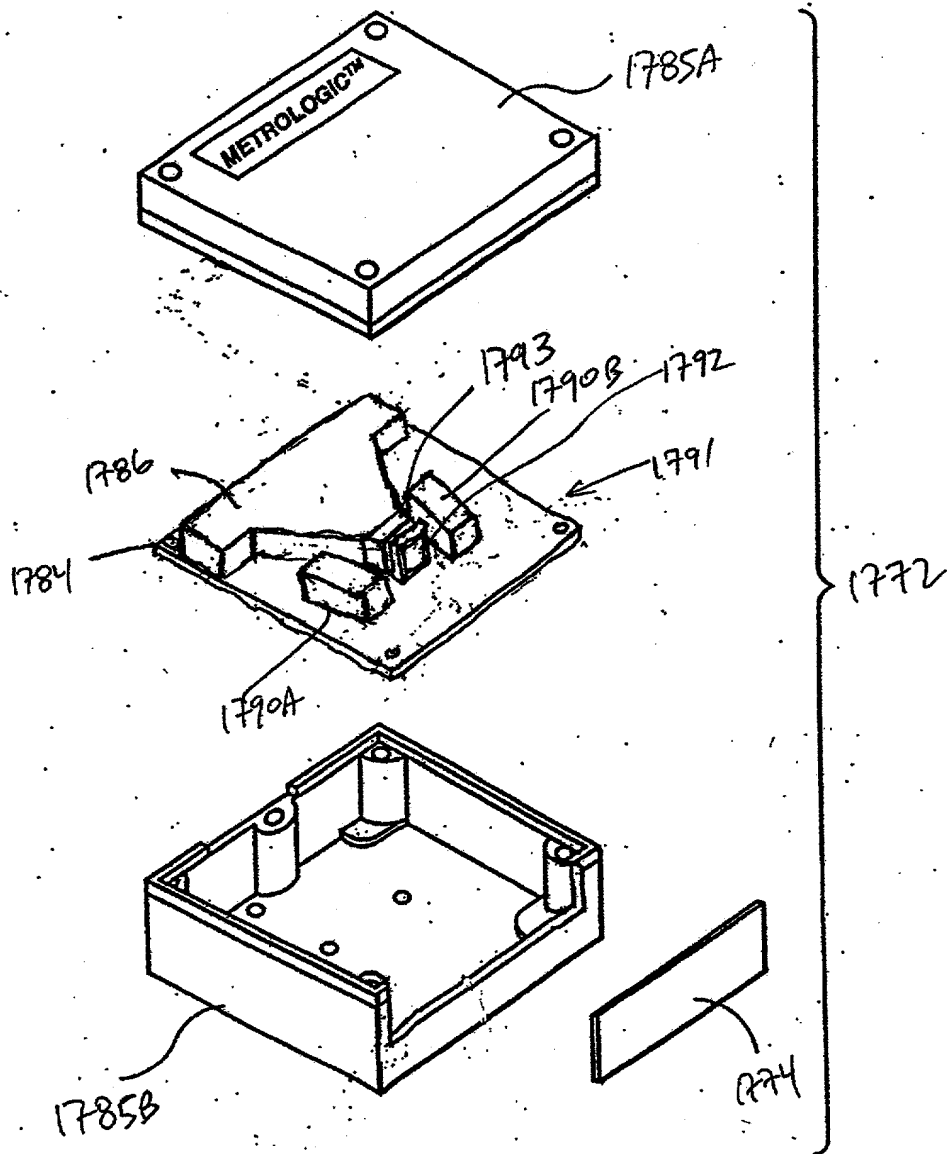


FIG. 50B

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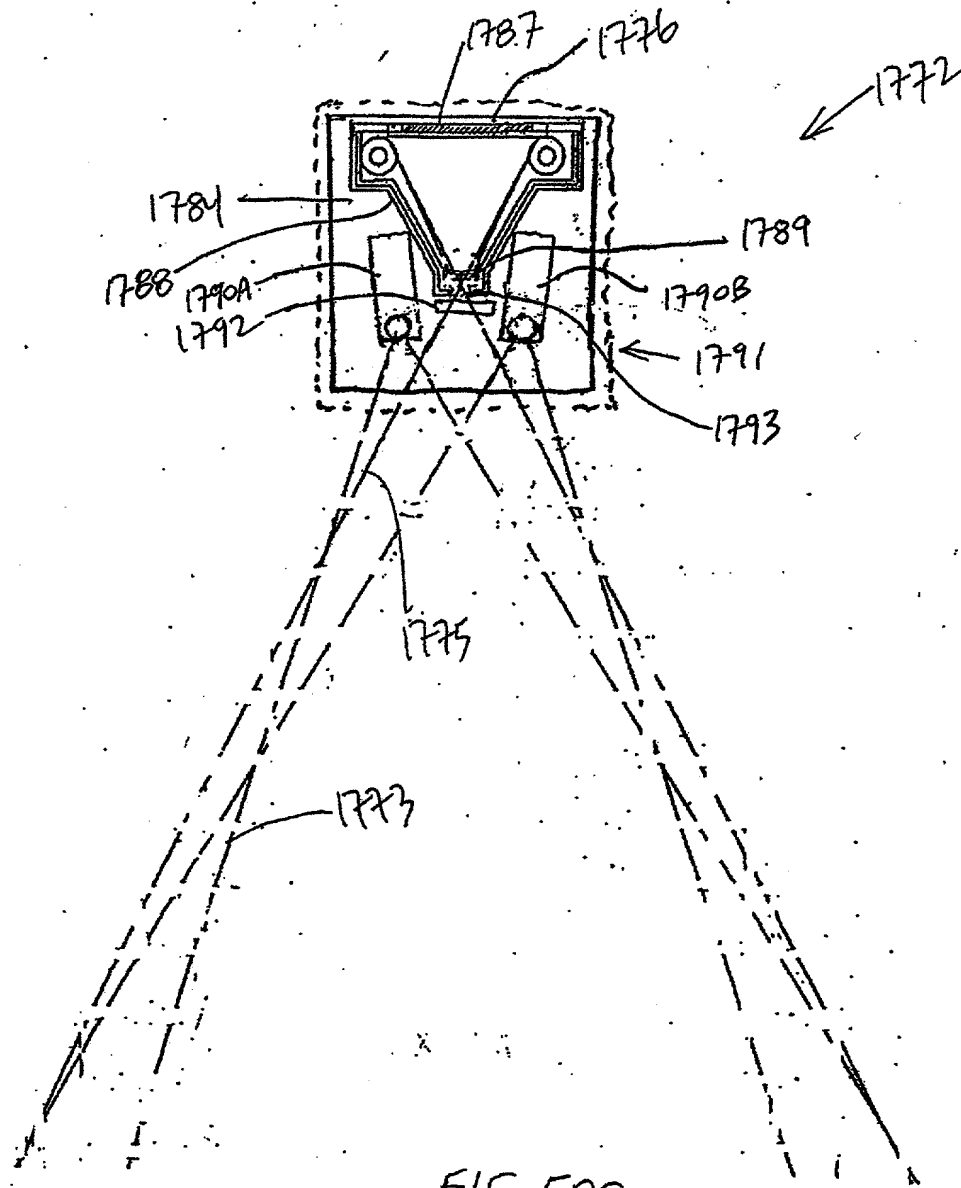


FIG. 50C

202020 29489001

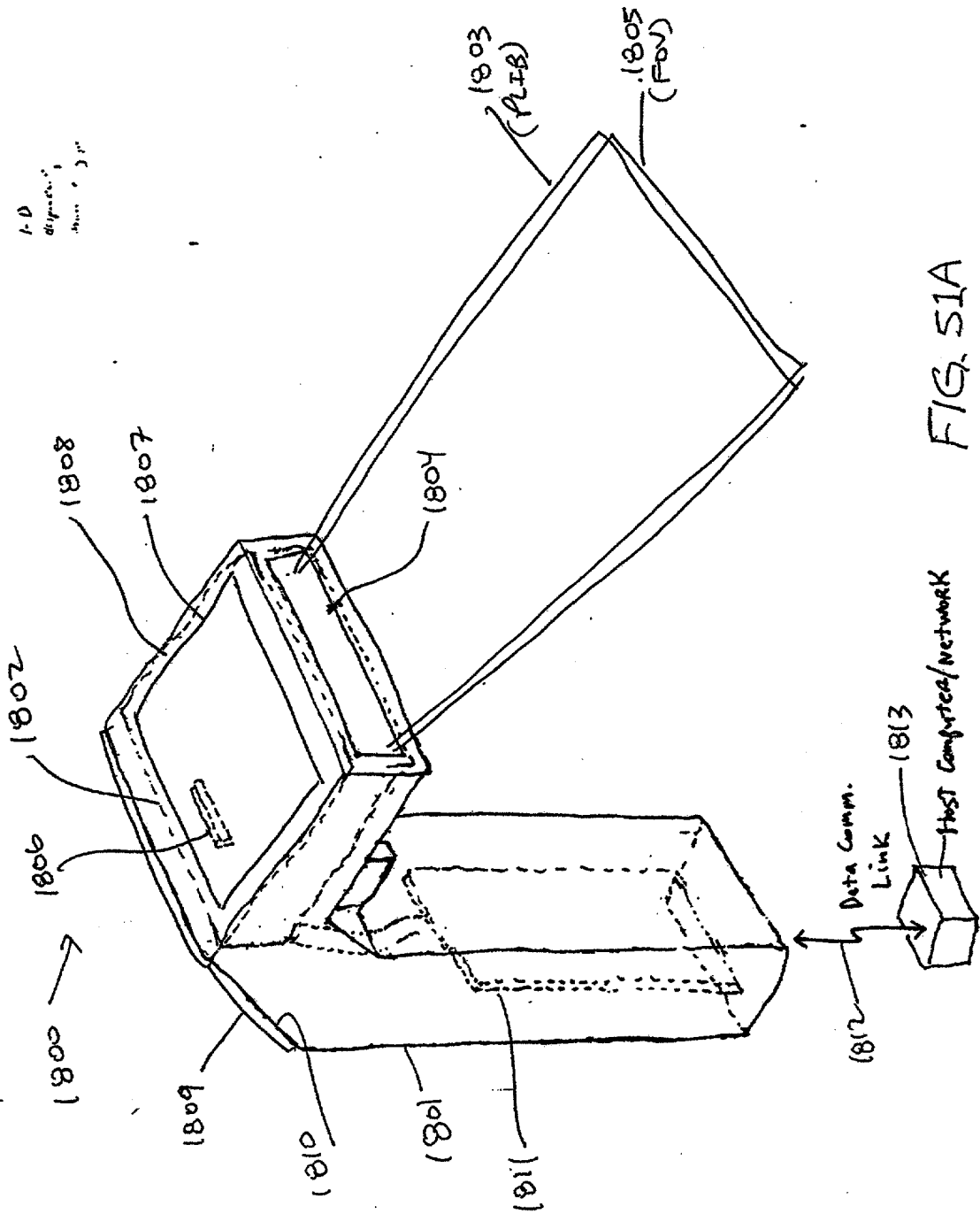


FIG. 51A

1006452.020702

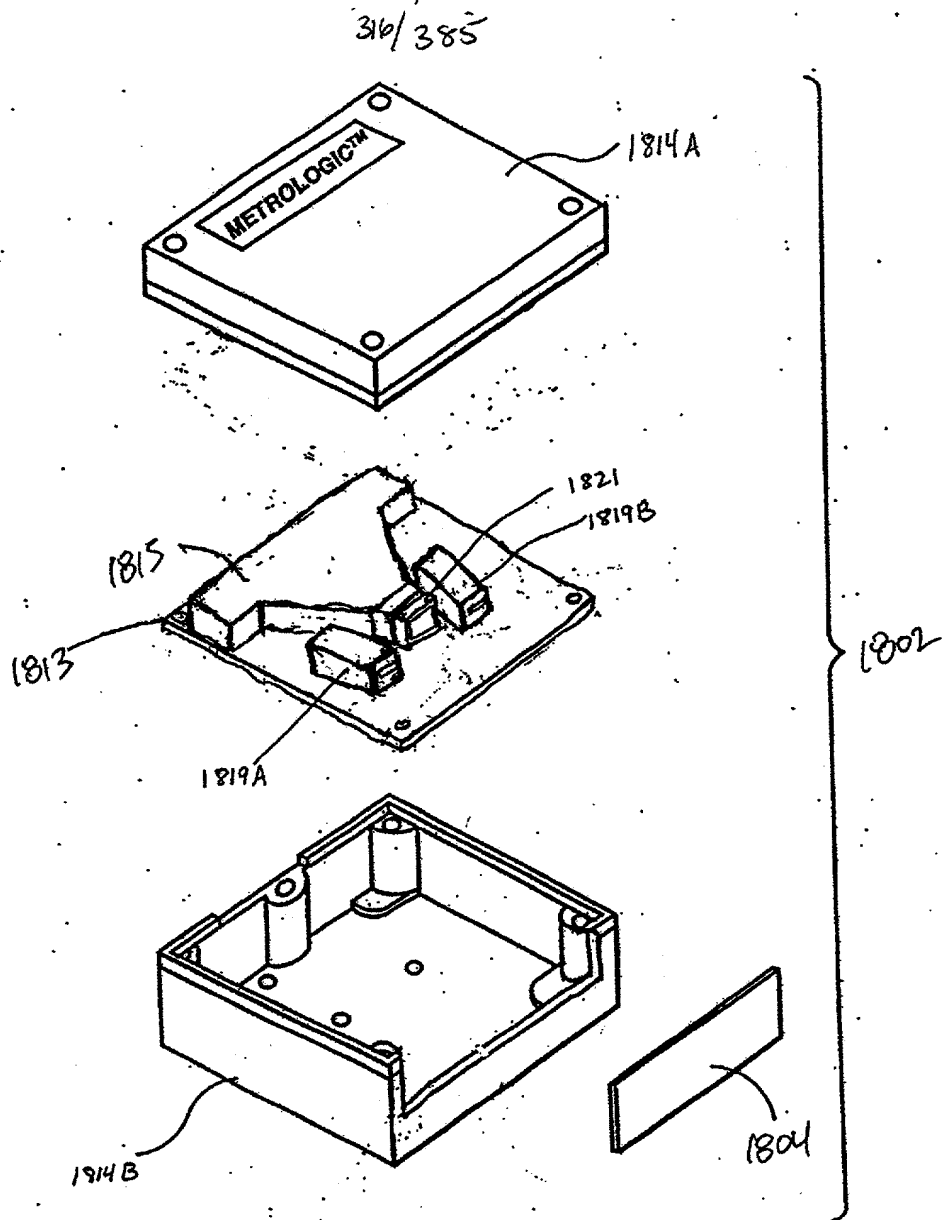
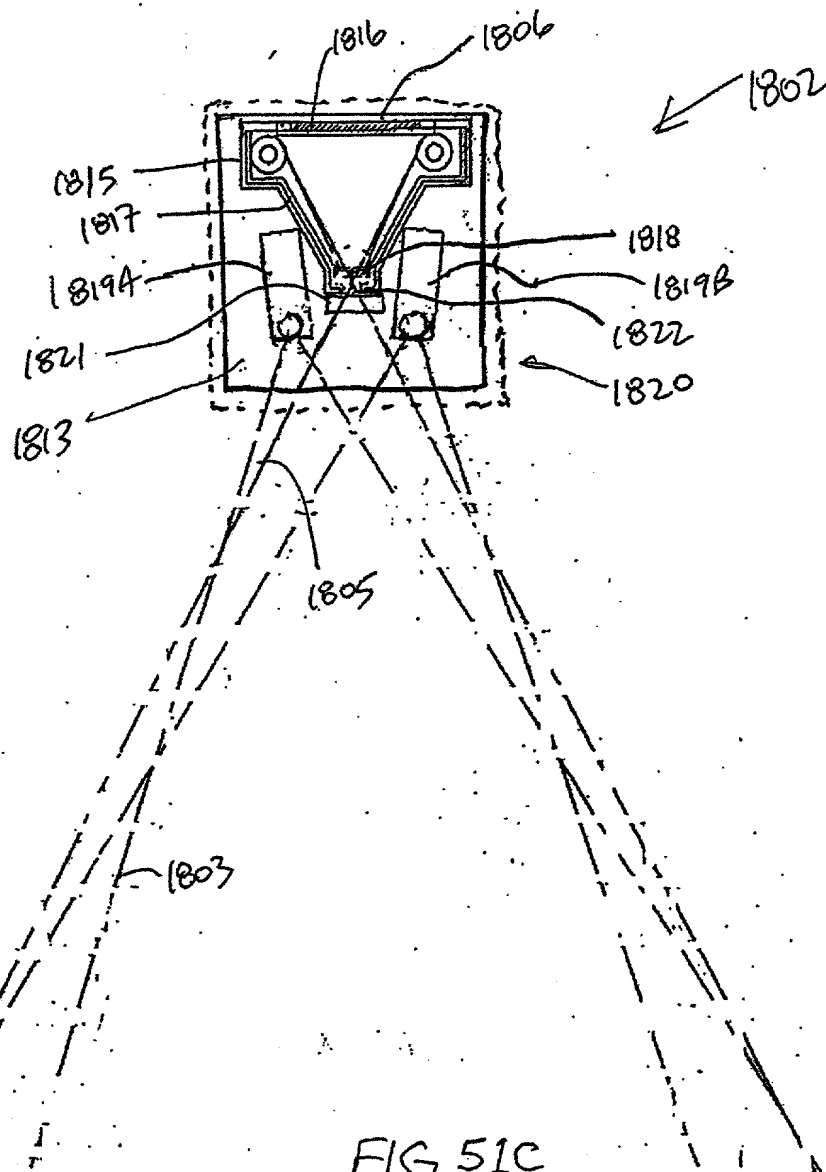


FIG. 51B



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100-443886-100

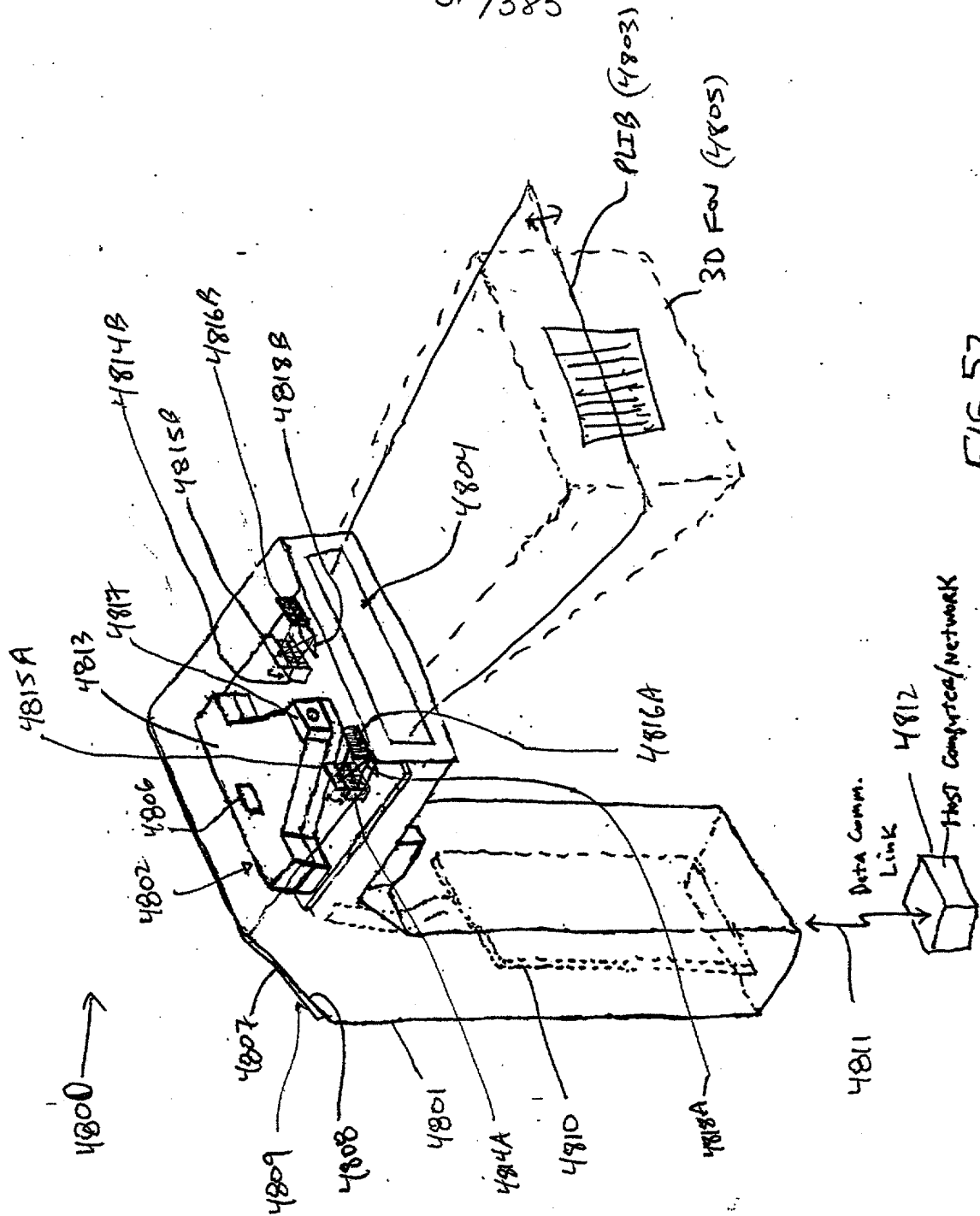


FIG. 52



10054452.020702

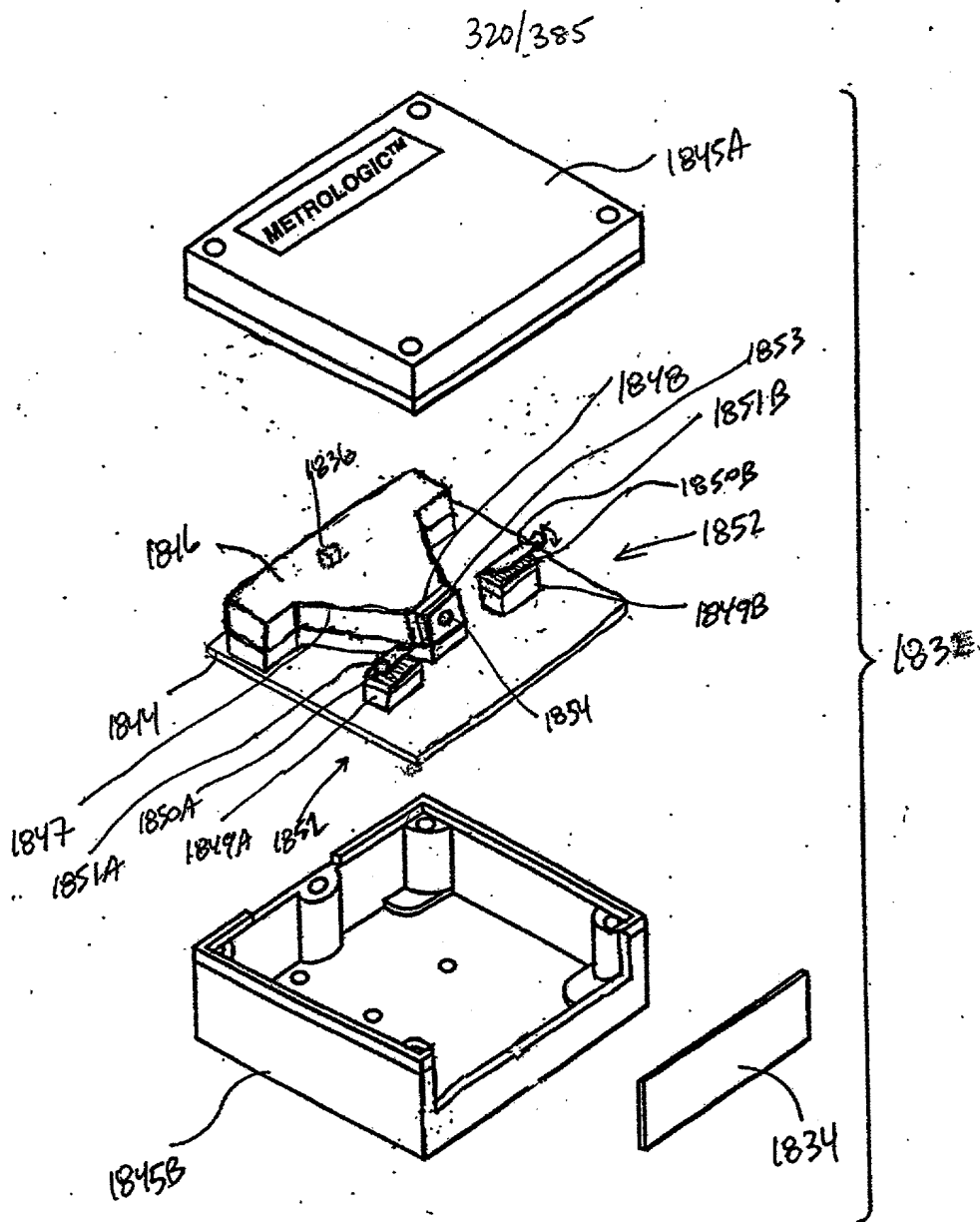


FIG. 52B

Fig. 1I 3A-3B

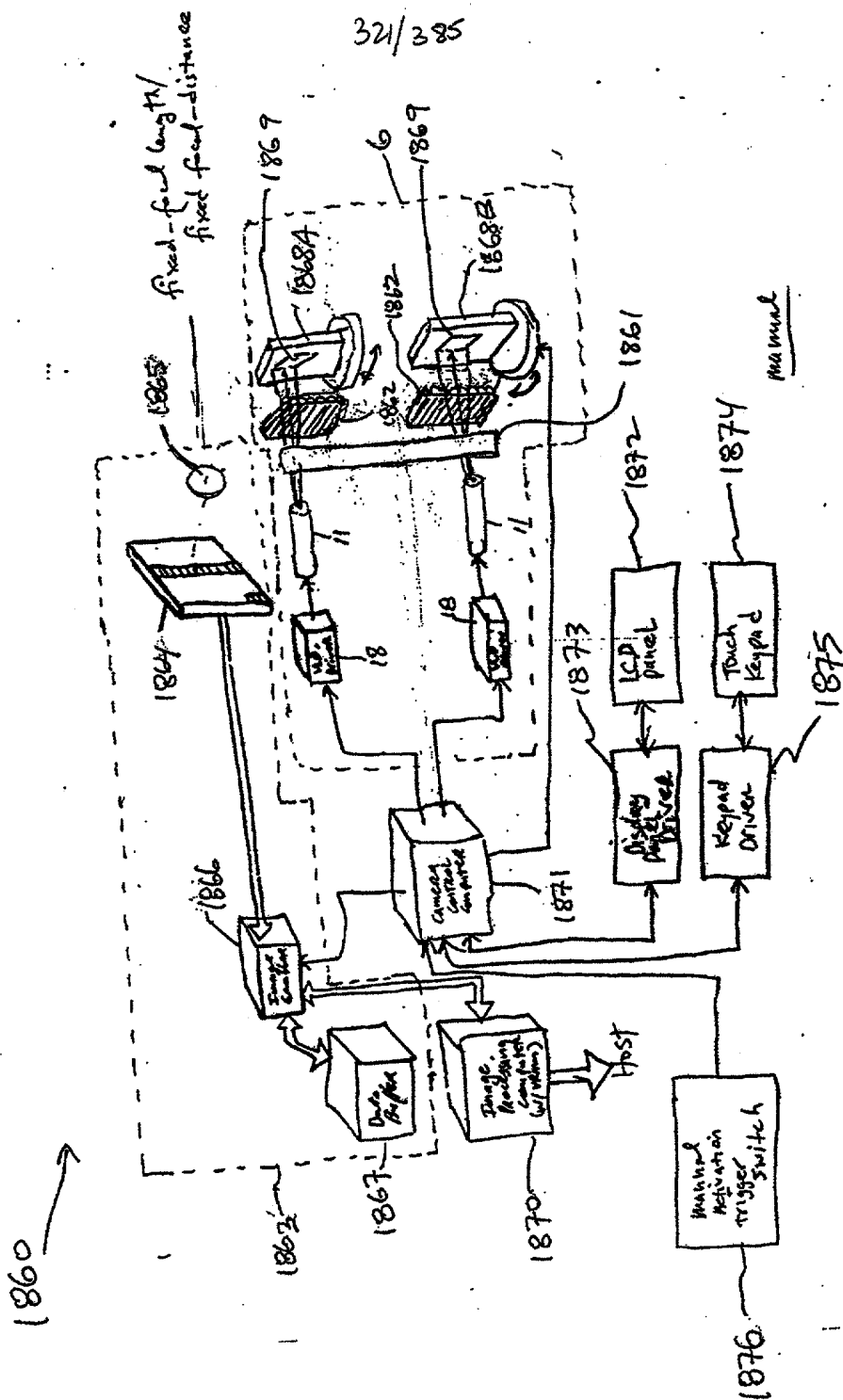
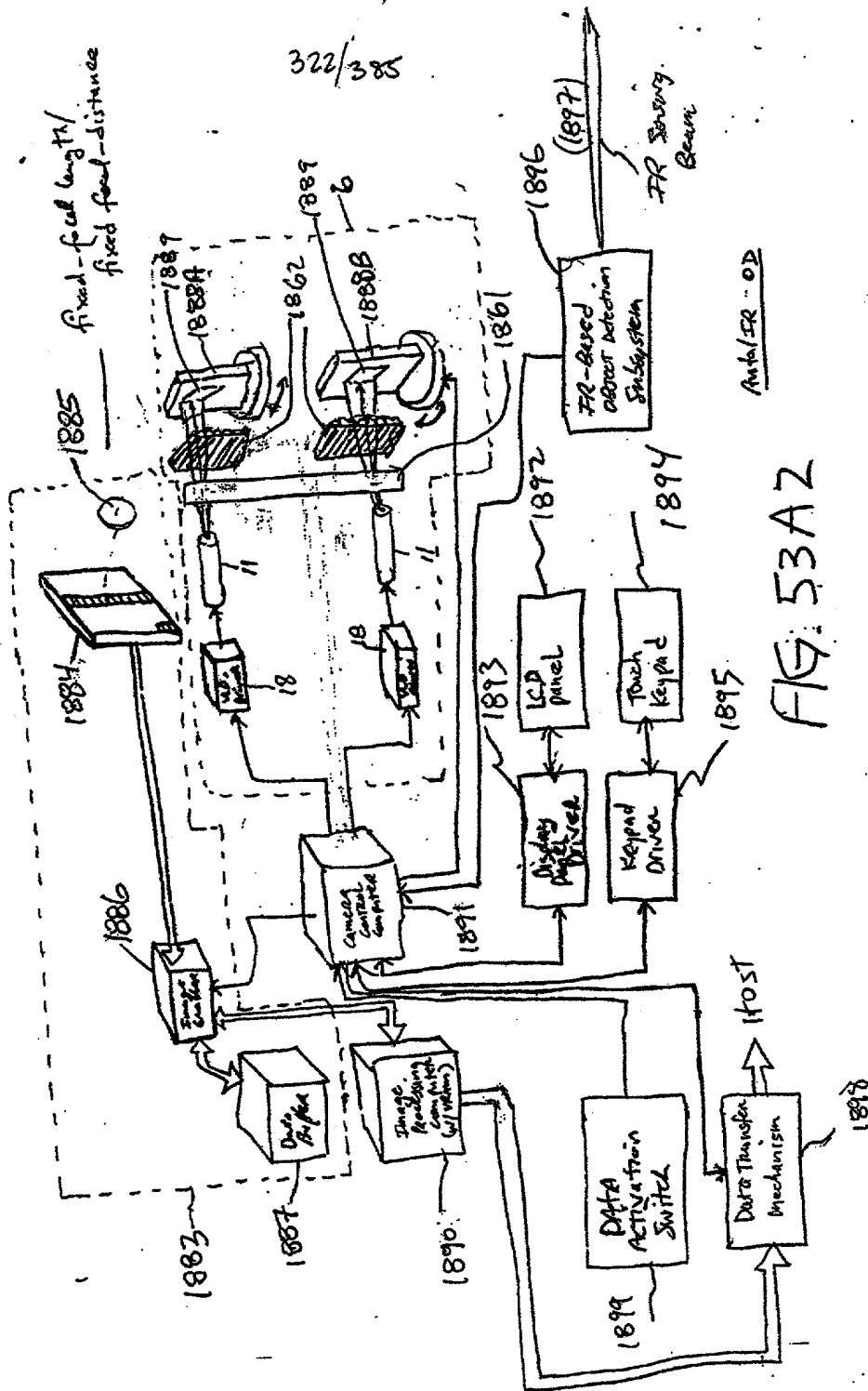


FIG. 53A1

1880





2022 →

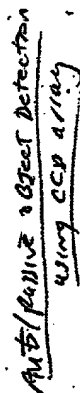


FIG. 53A4



2040

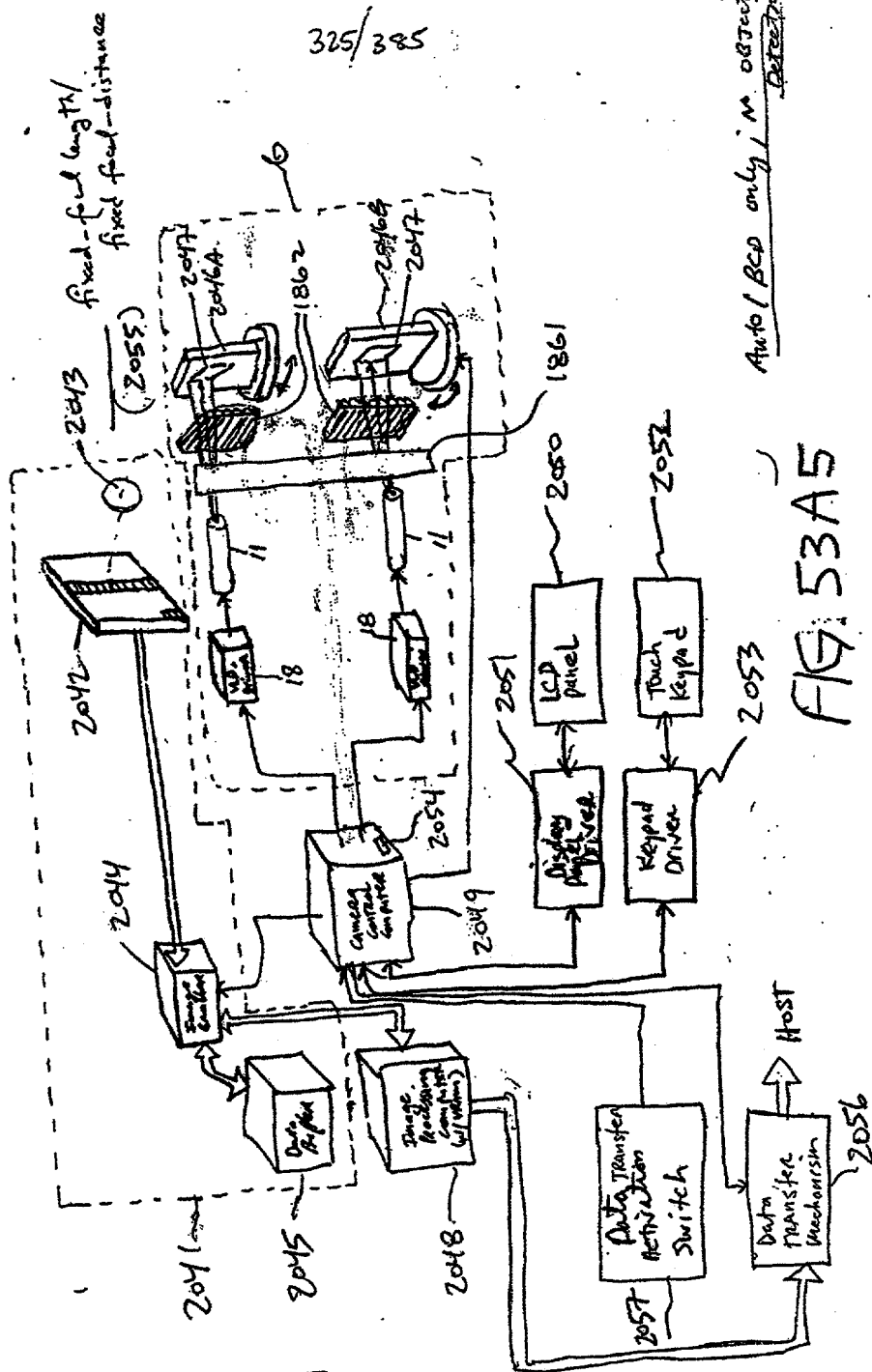


FIG. 53A5

fixed focal length/  
variable focal distance

2060 →

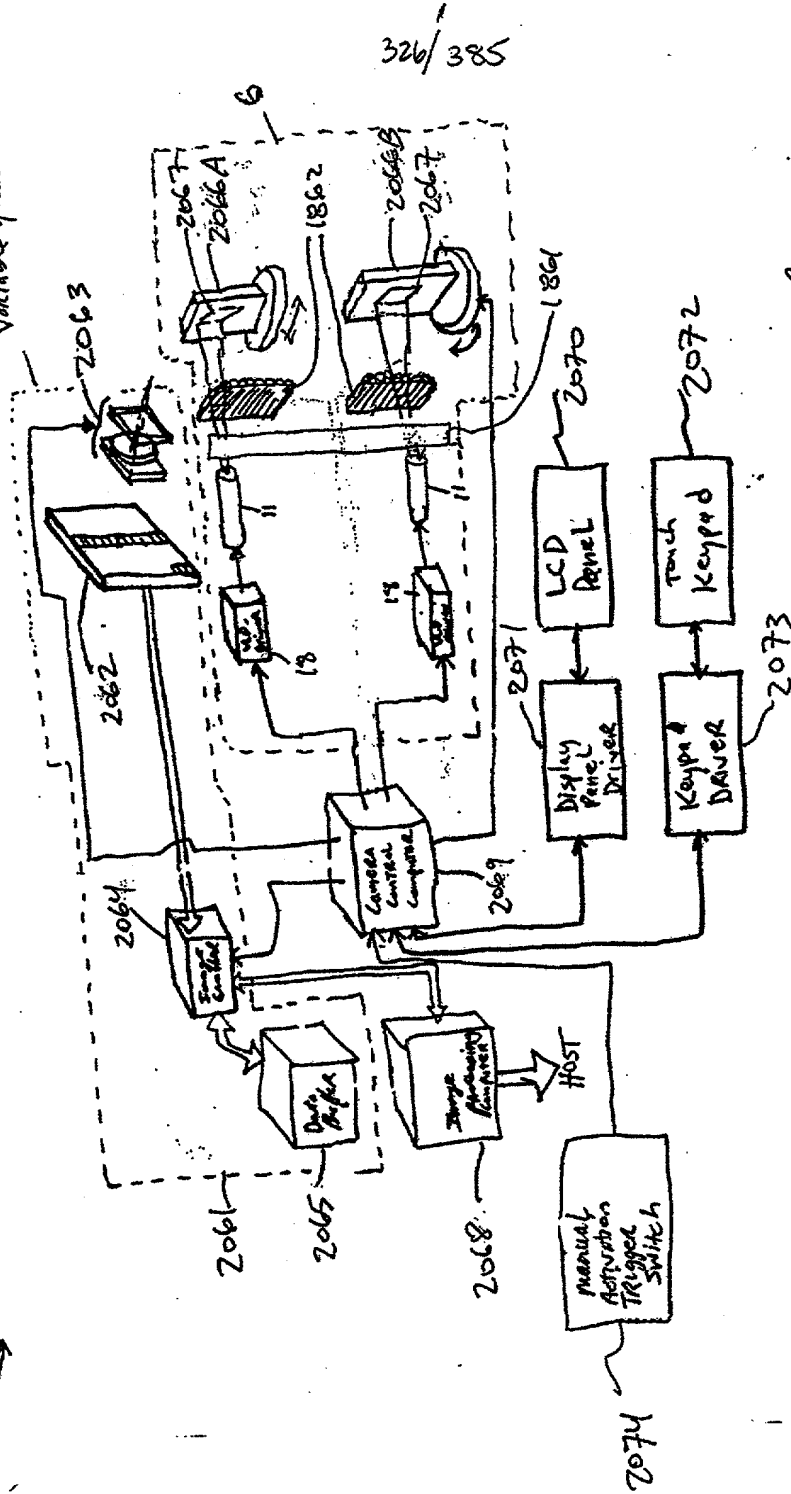


FIG. 53B1

Manual

2080 →

fixed focal length/  
variable focal distance

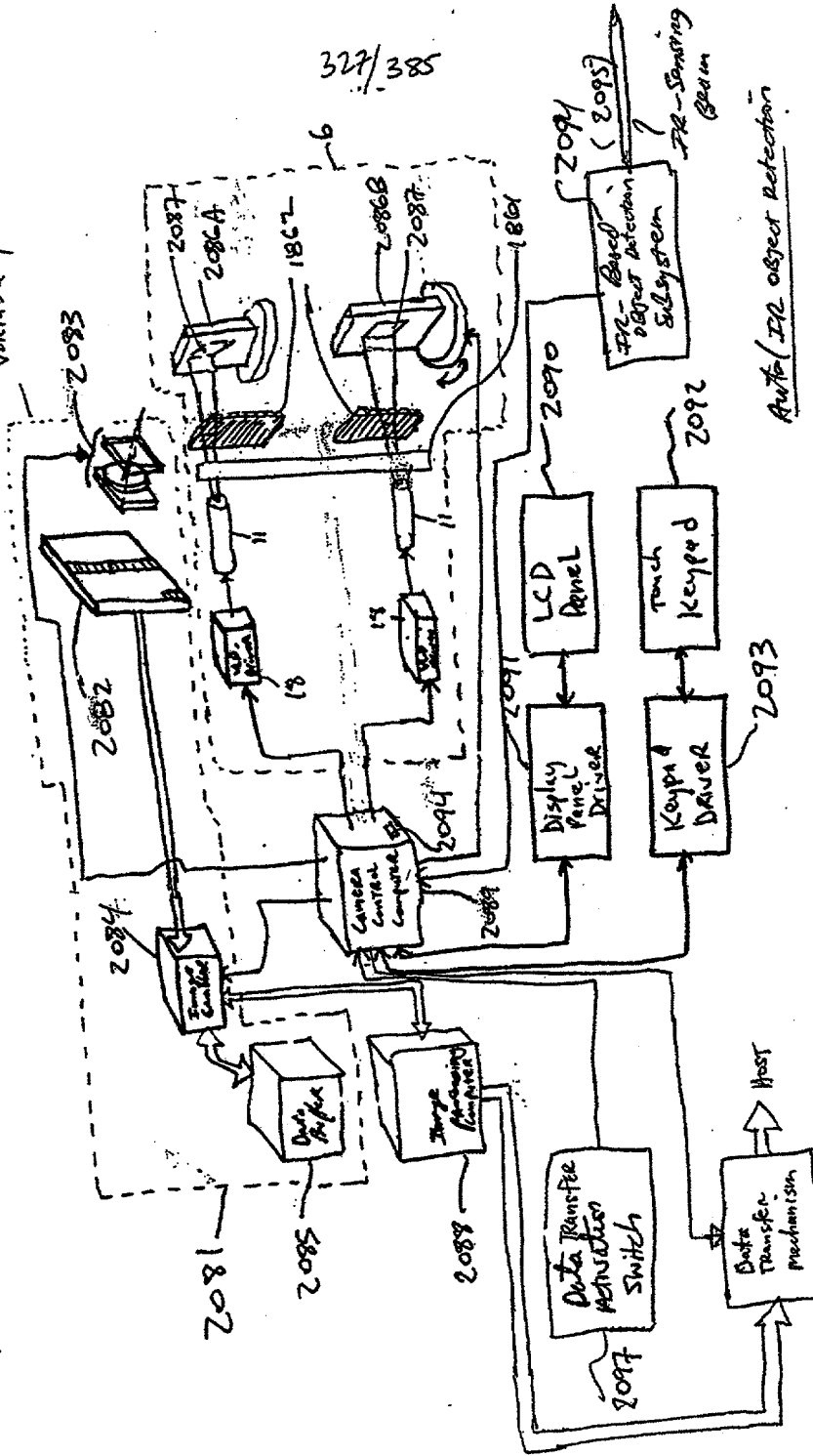
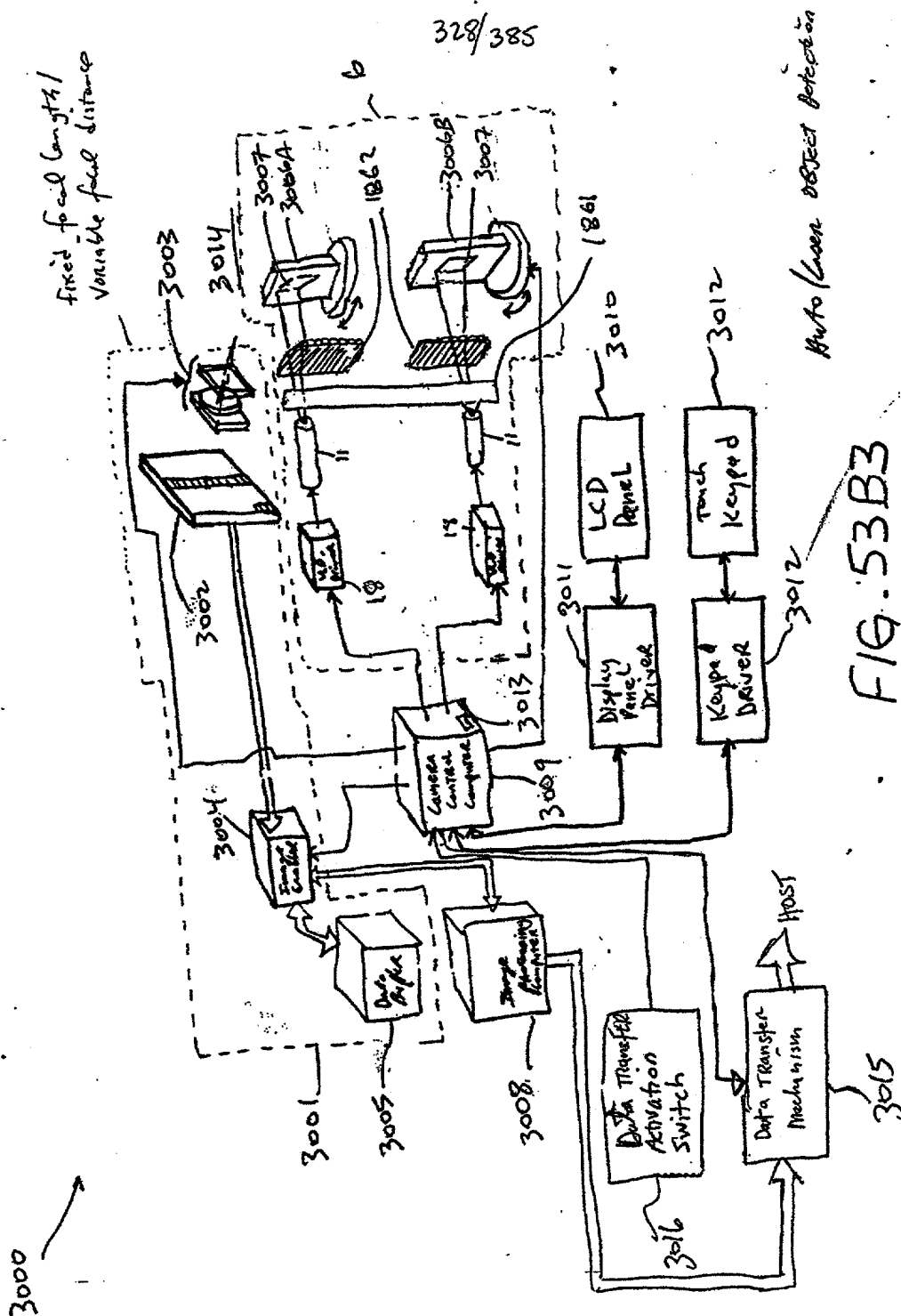
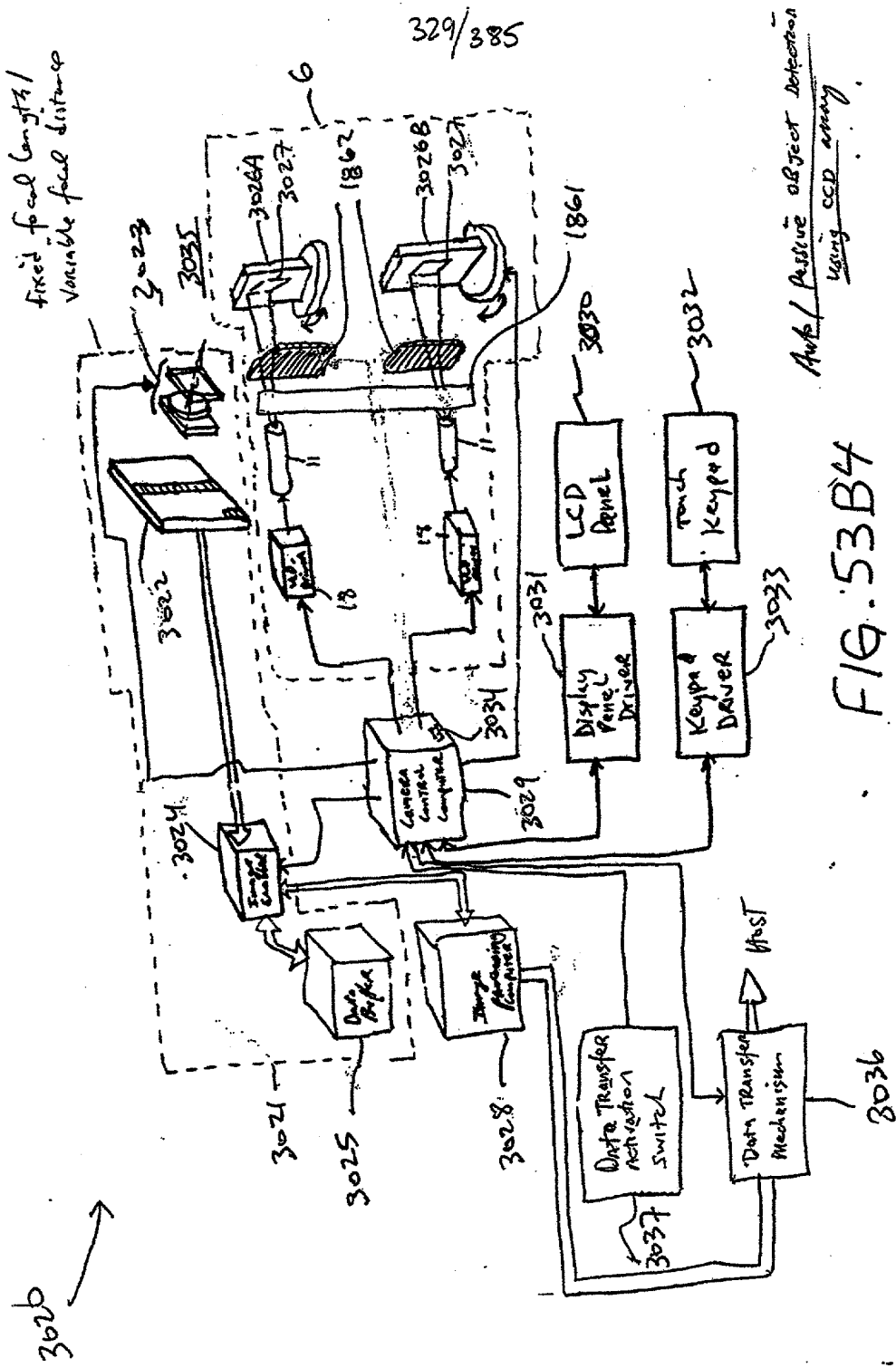
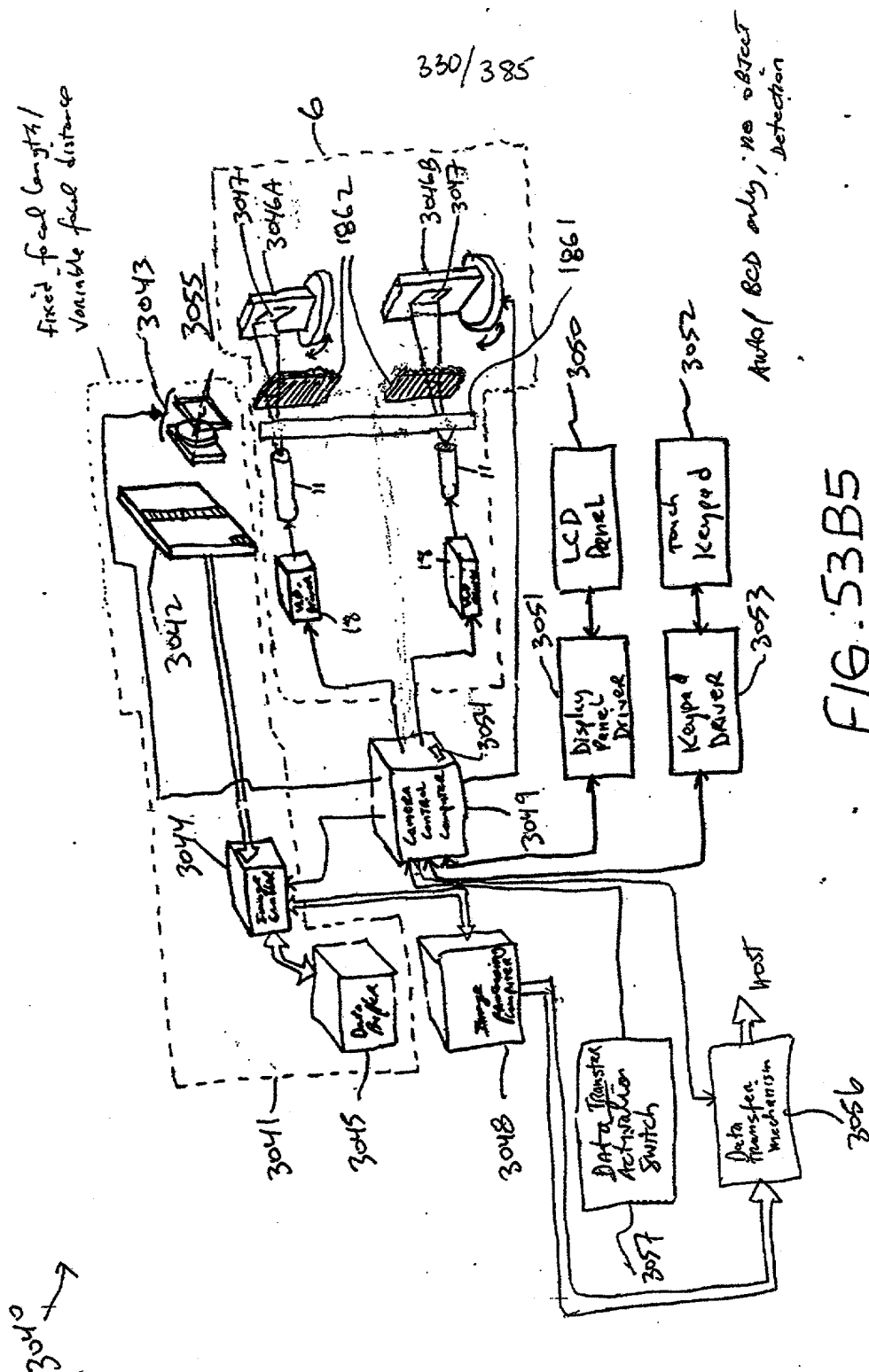


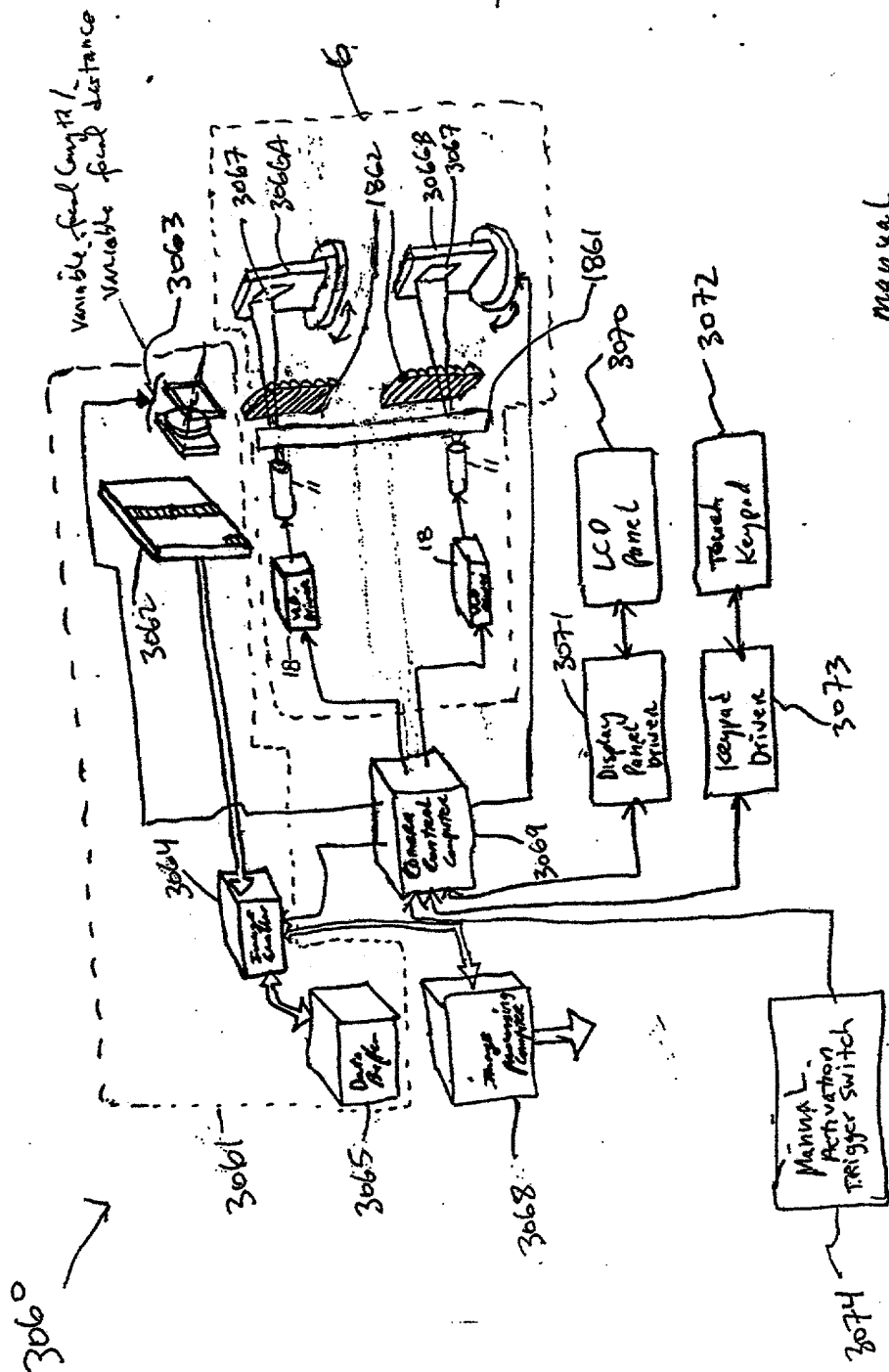
FIG. 53B2

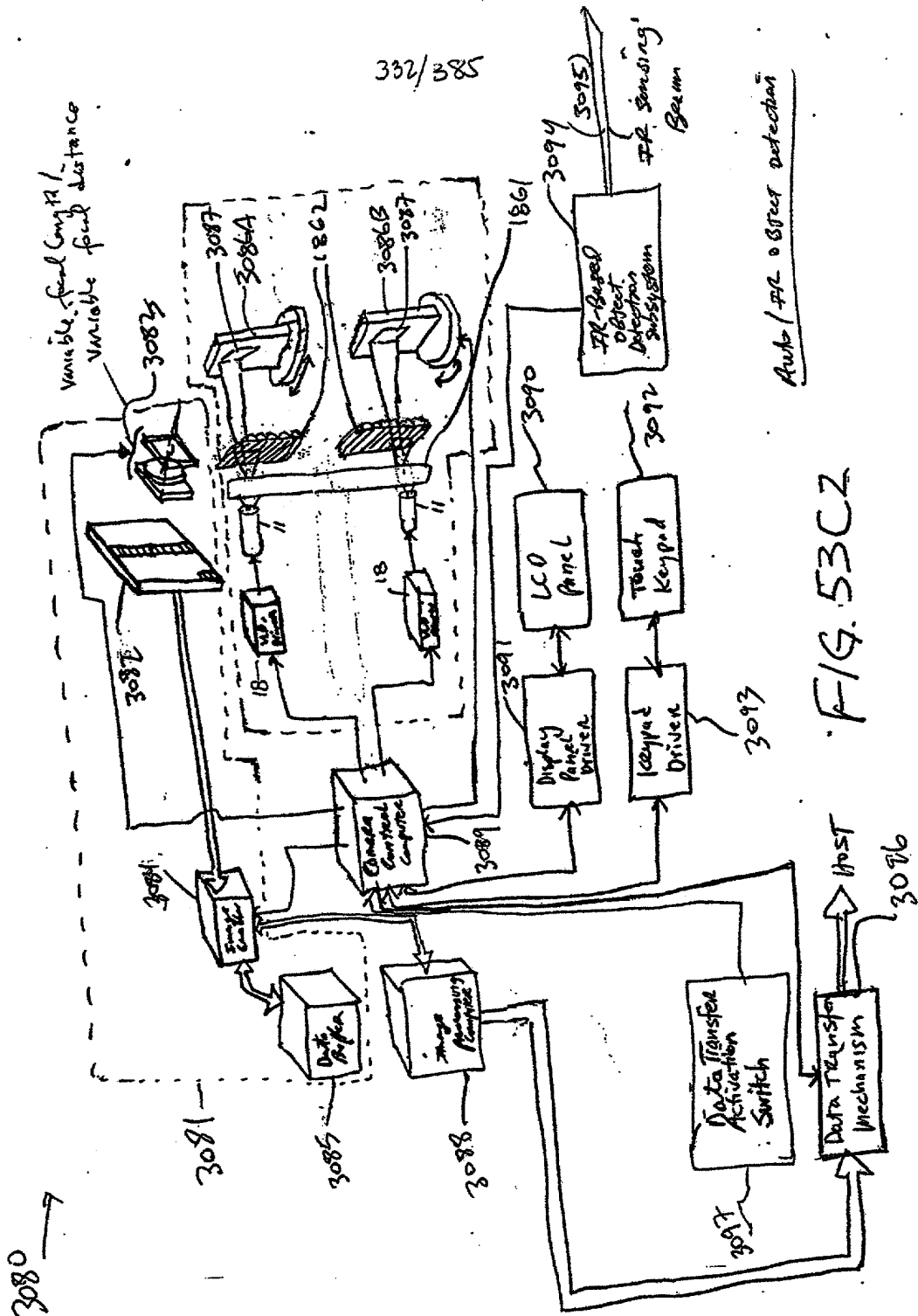
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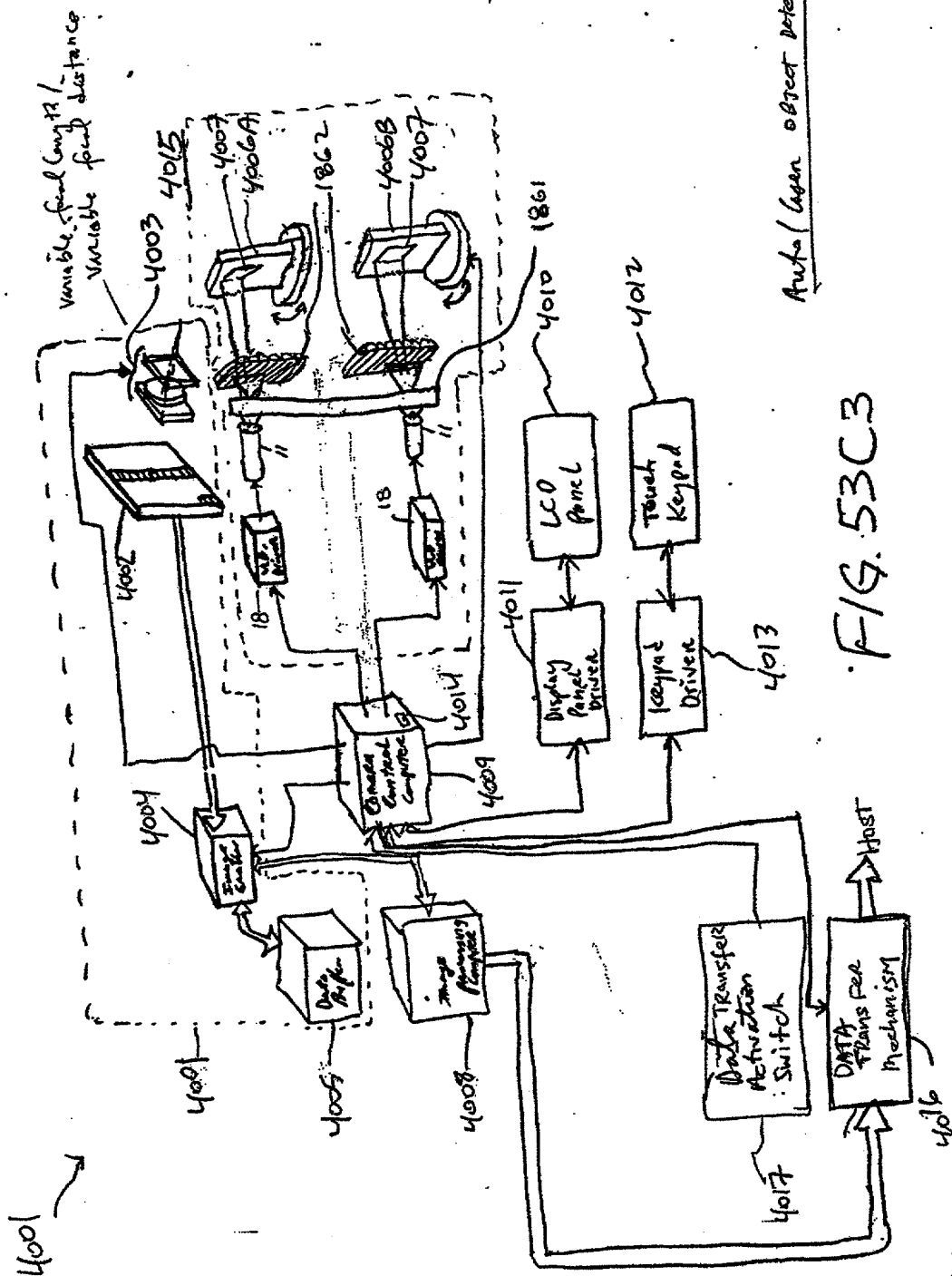






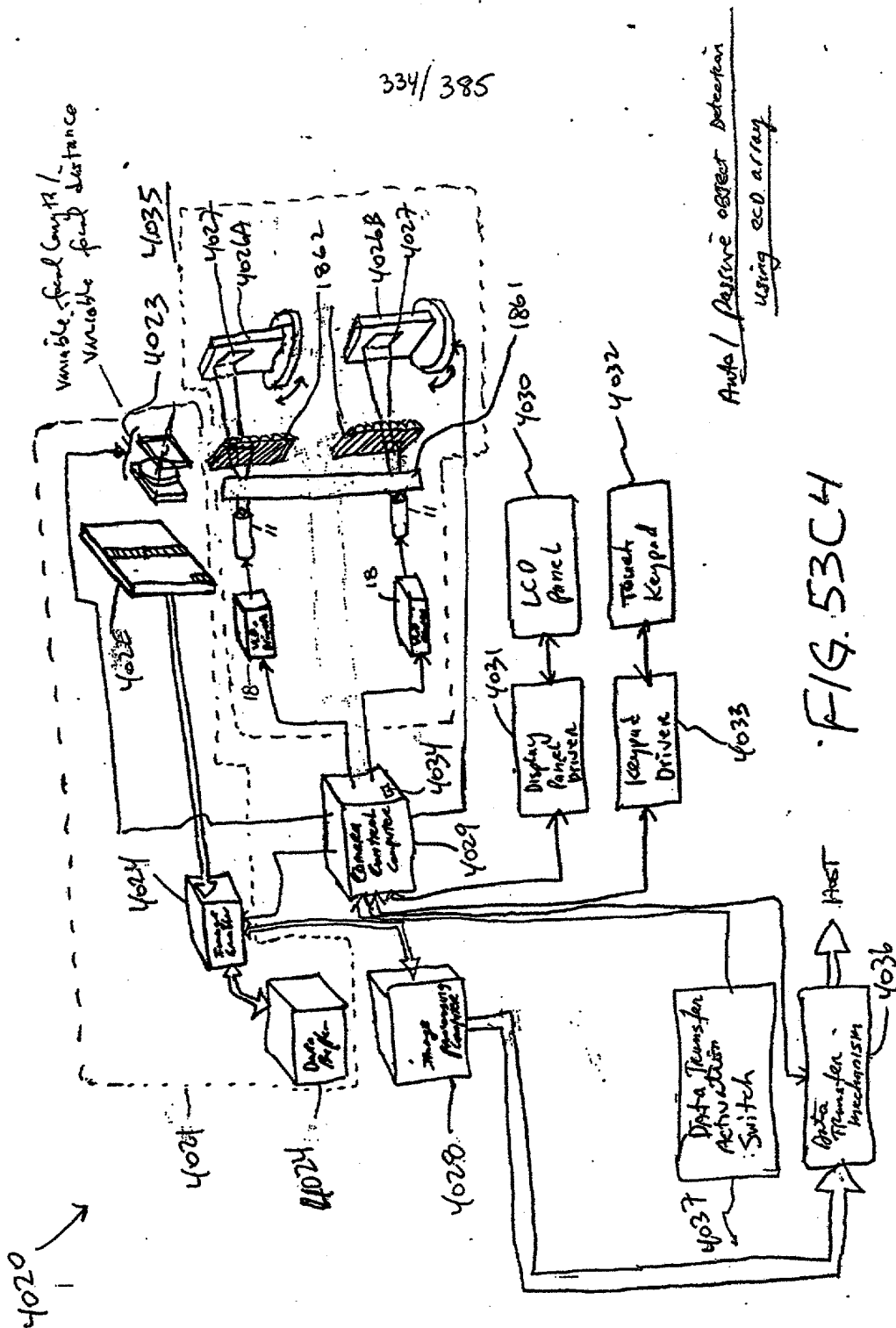




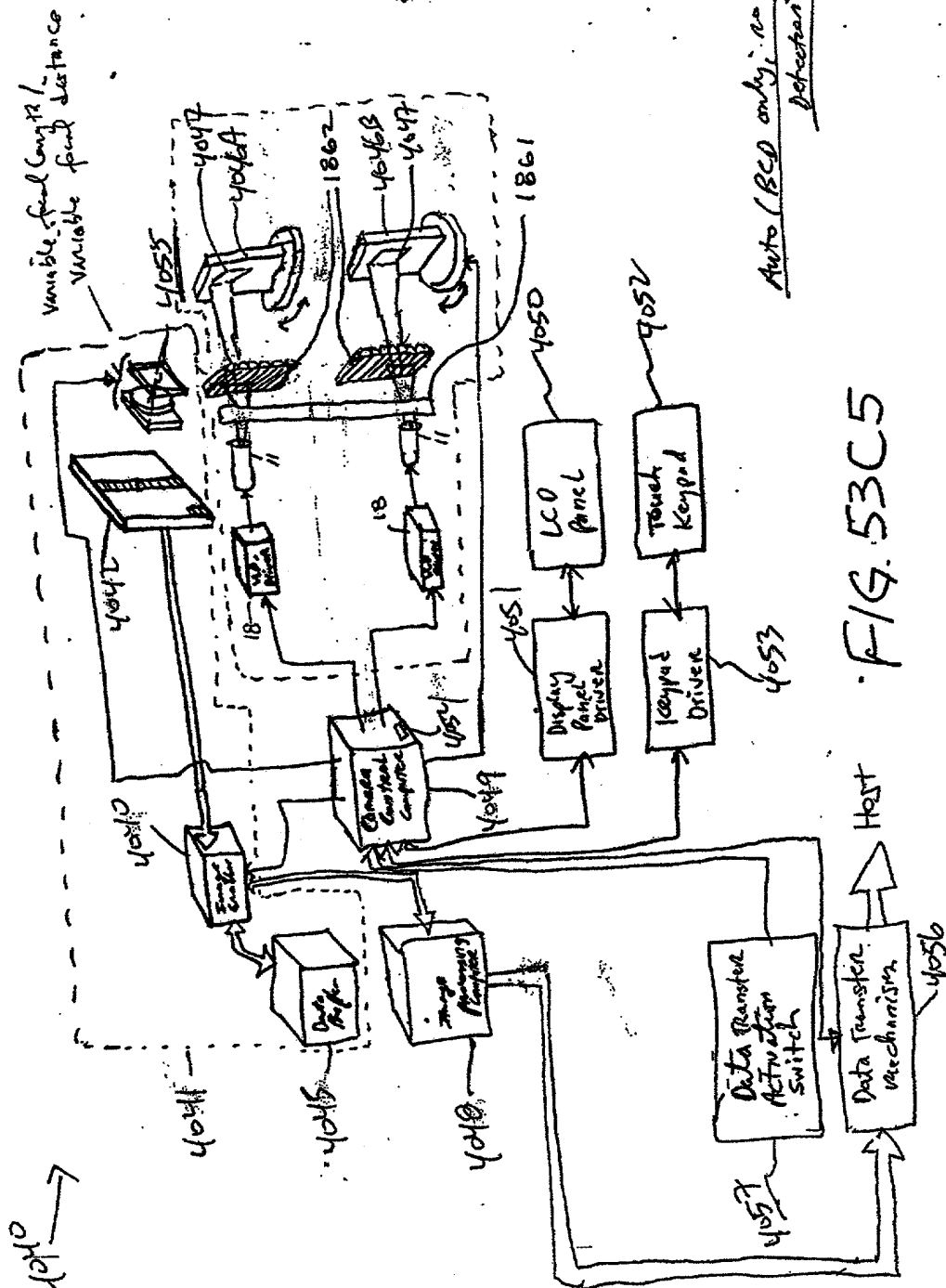


Auto/Laser Object Detection

FIG. 53C3

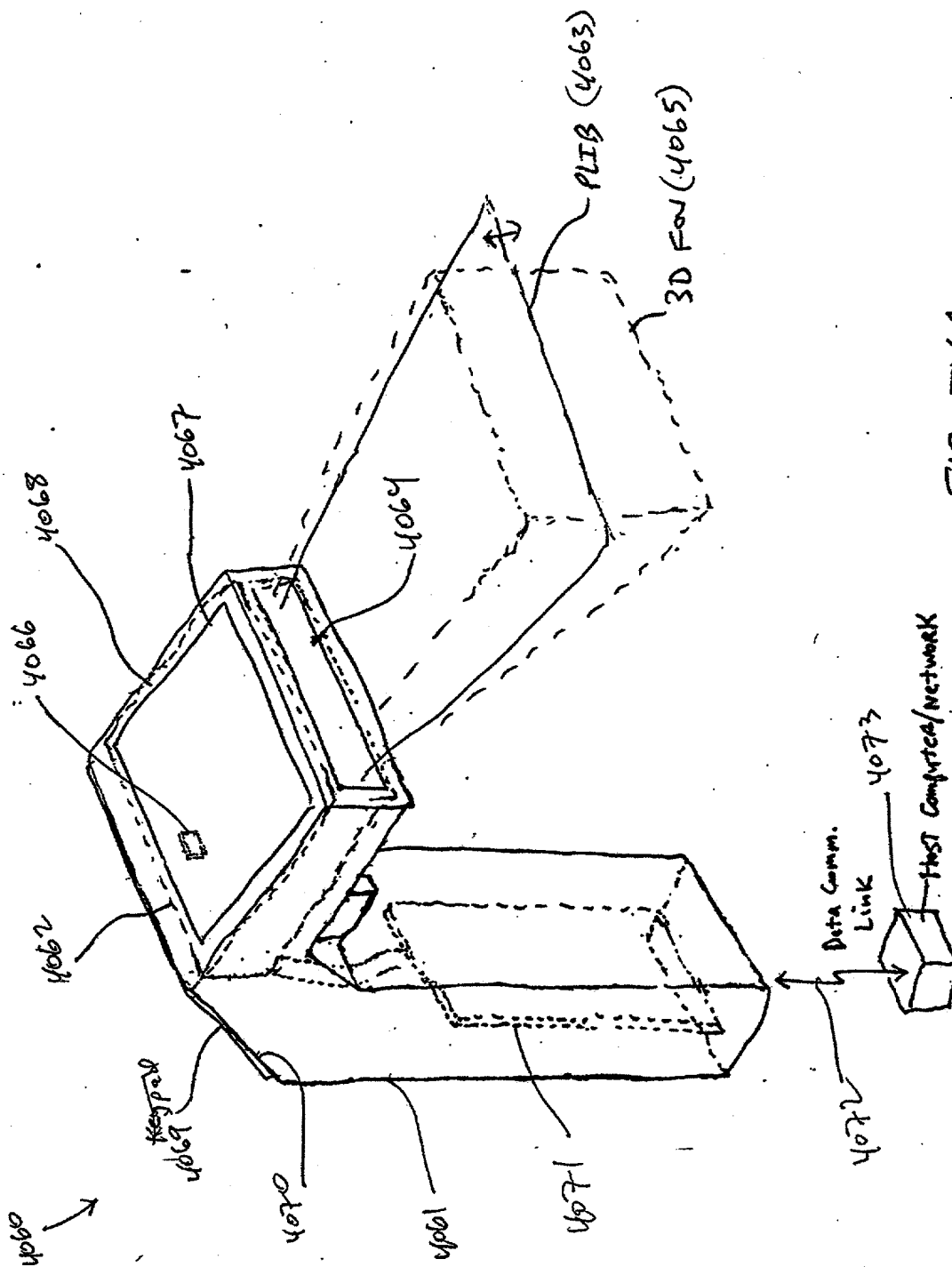


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Auto (BCD only) no object detection

FIG. 53C5



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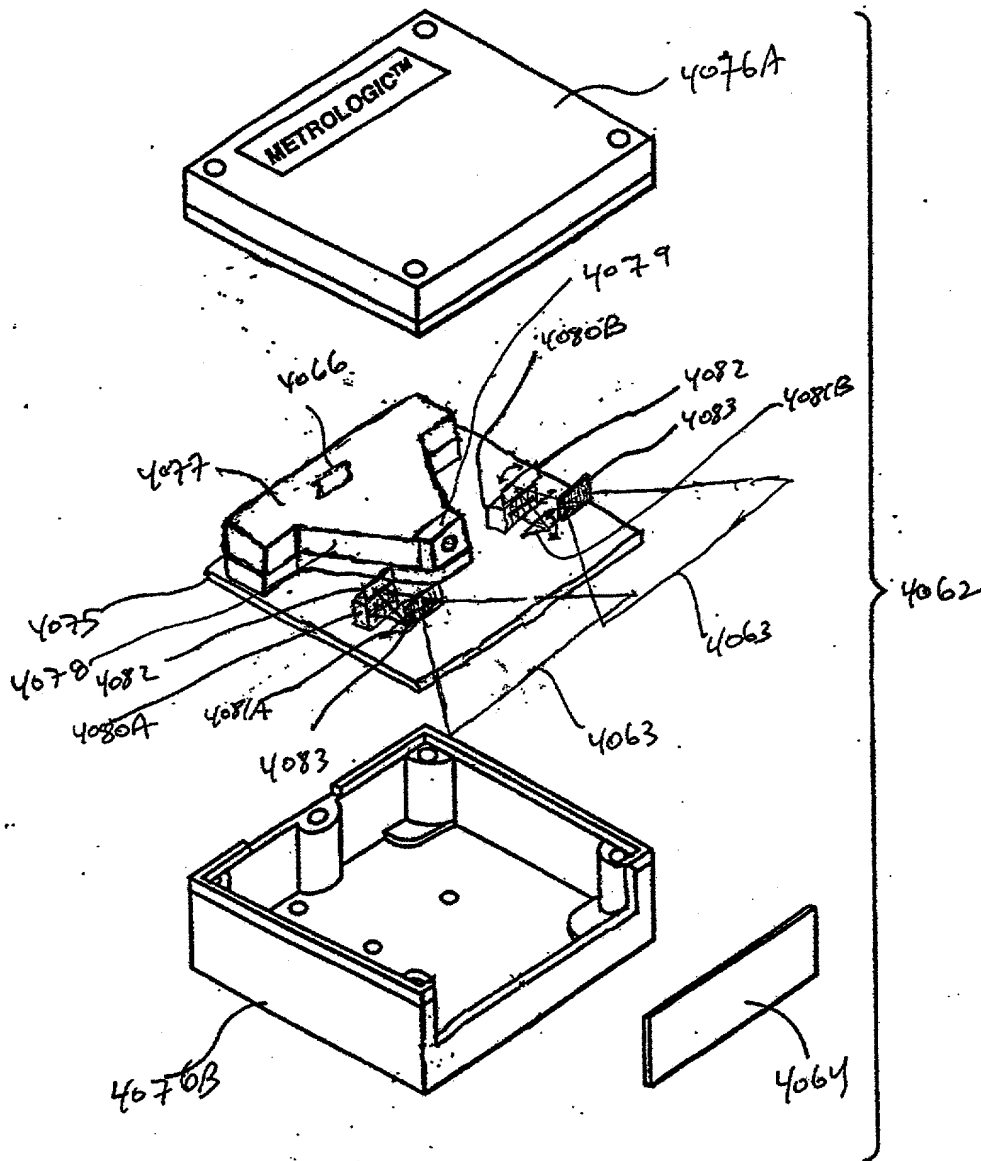


FIG. 54B

(dual mirror)  
Fig. 175A-SP1

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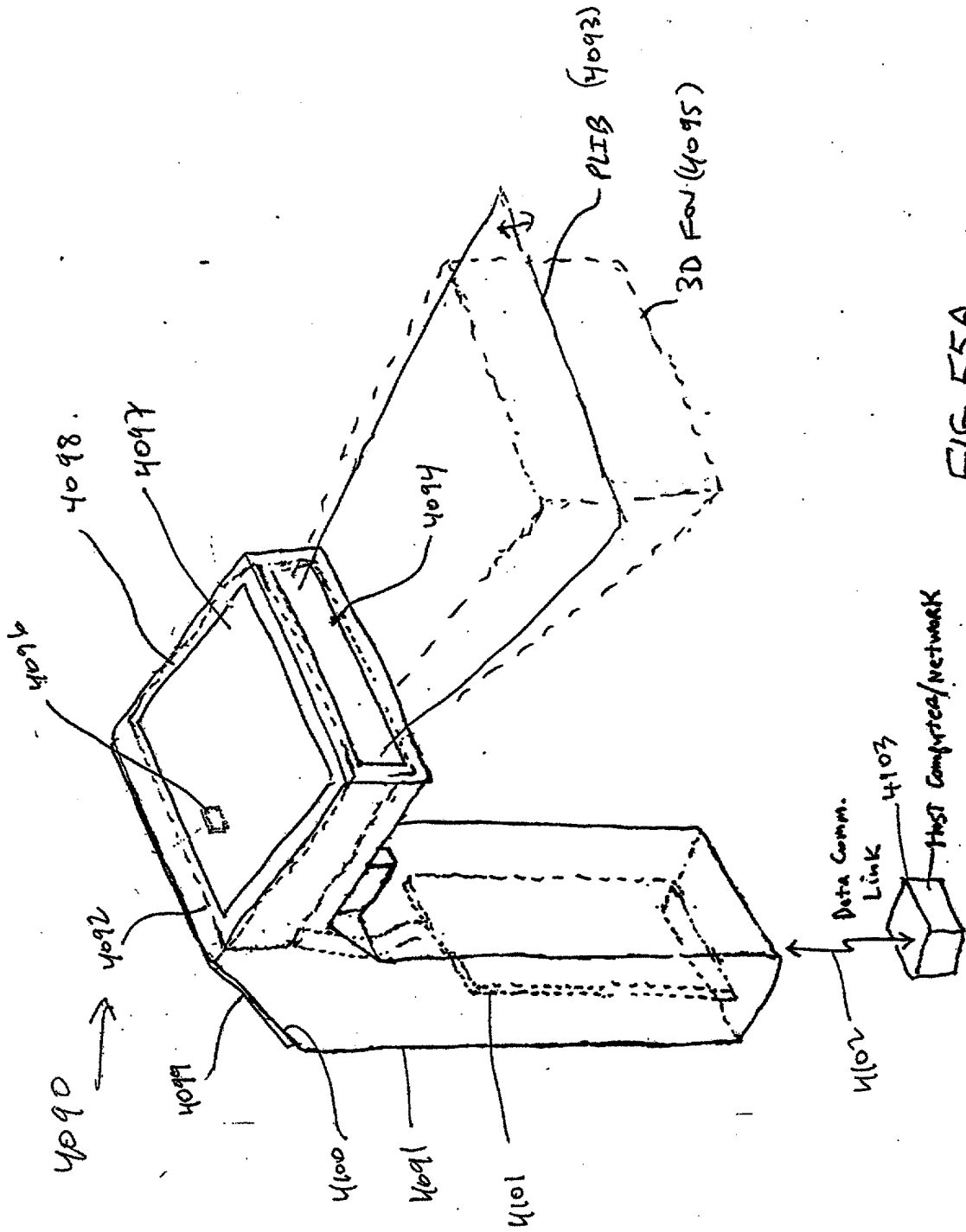


FIG. 55A

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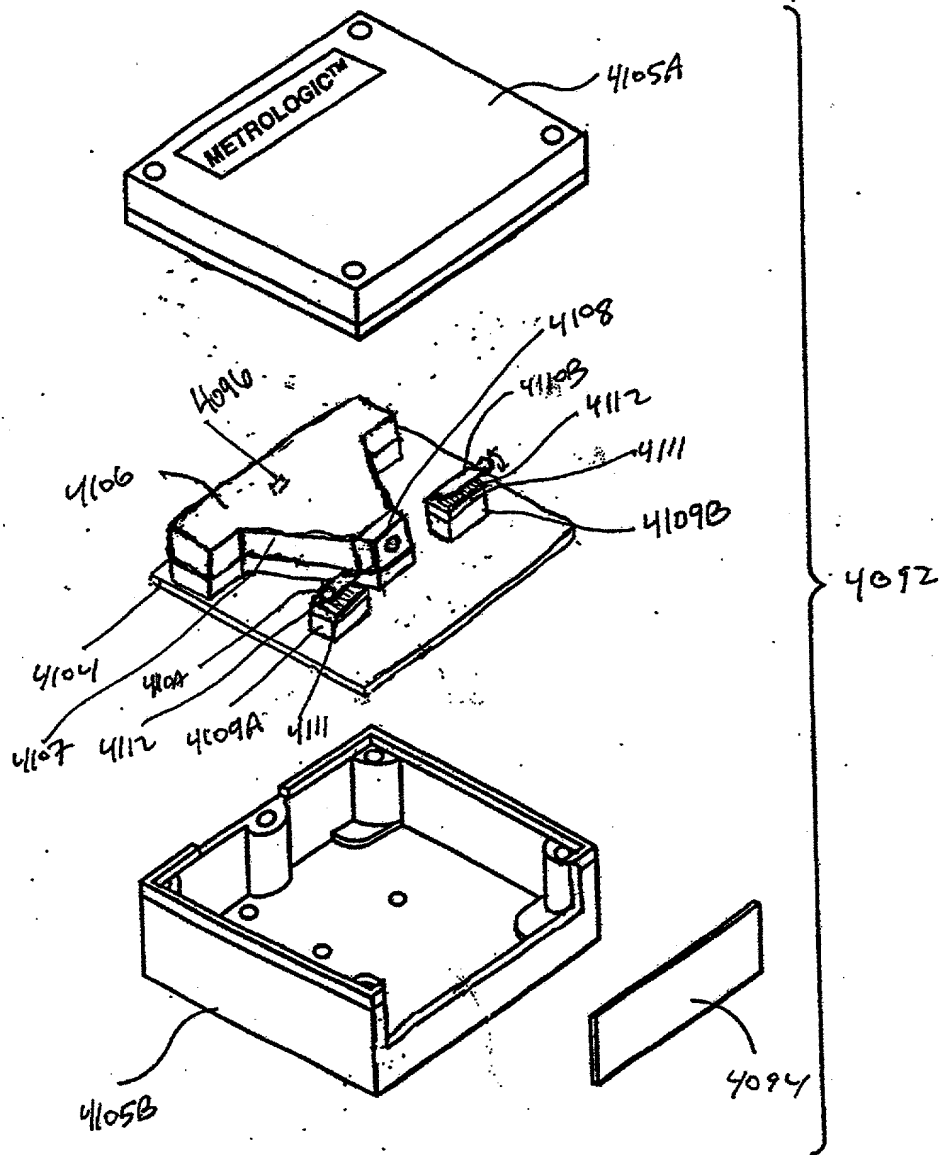


FIG. 55B

Brooks cell  
Fig. 126A-6B

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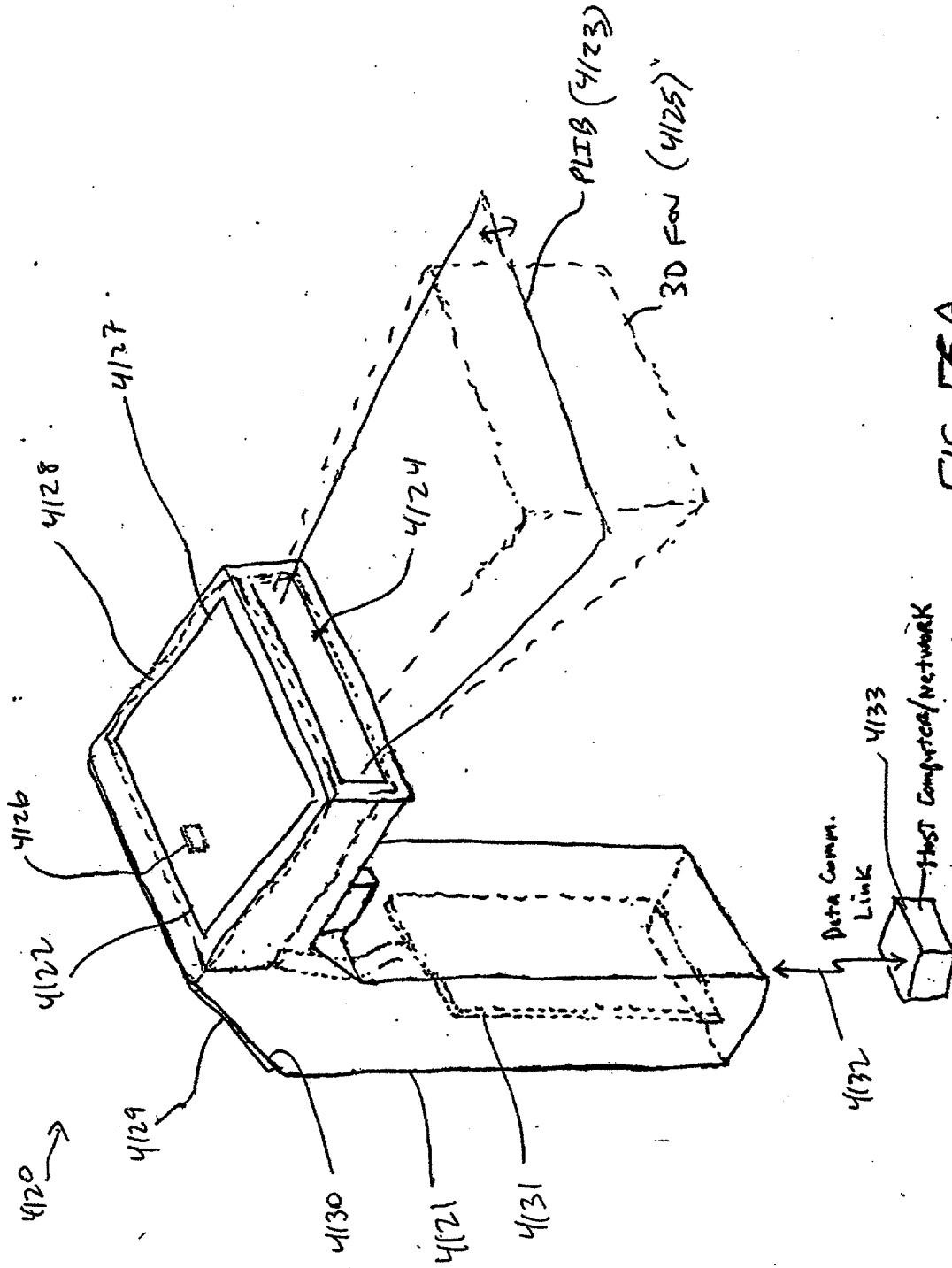


FIG. 56A



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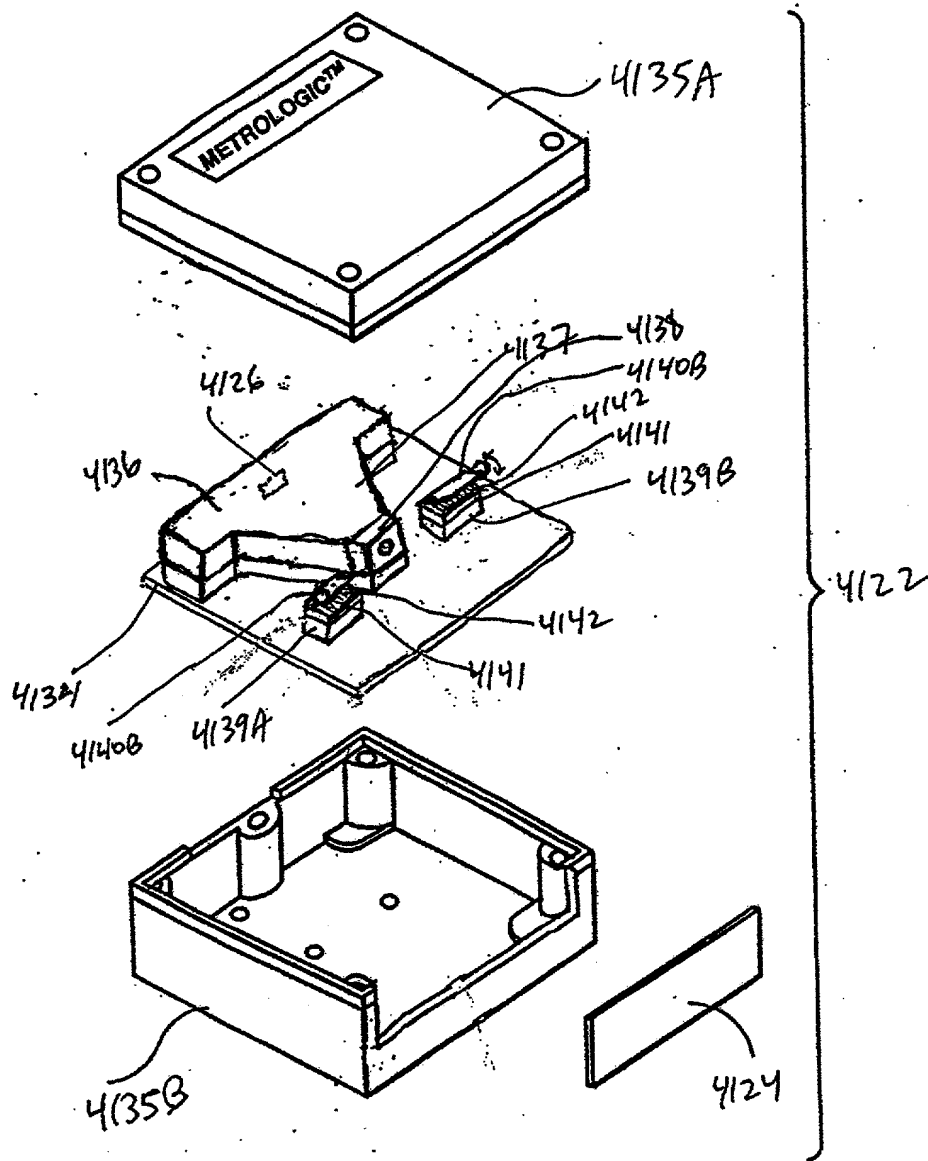


FIG. 56B

DM

Fig. 1F7A-7C

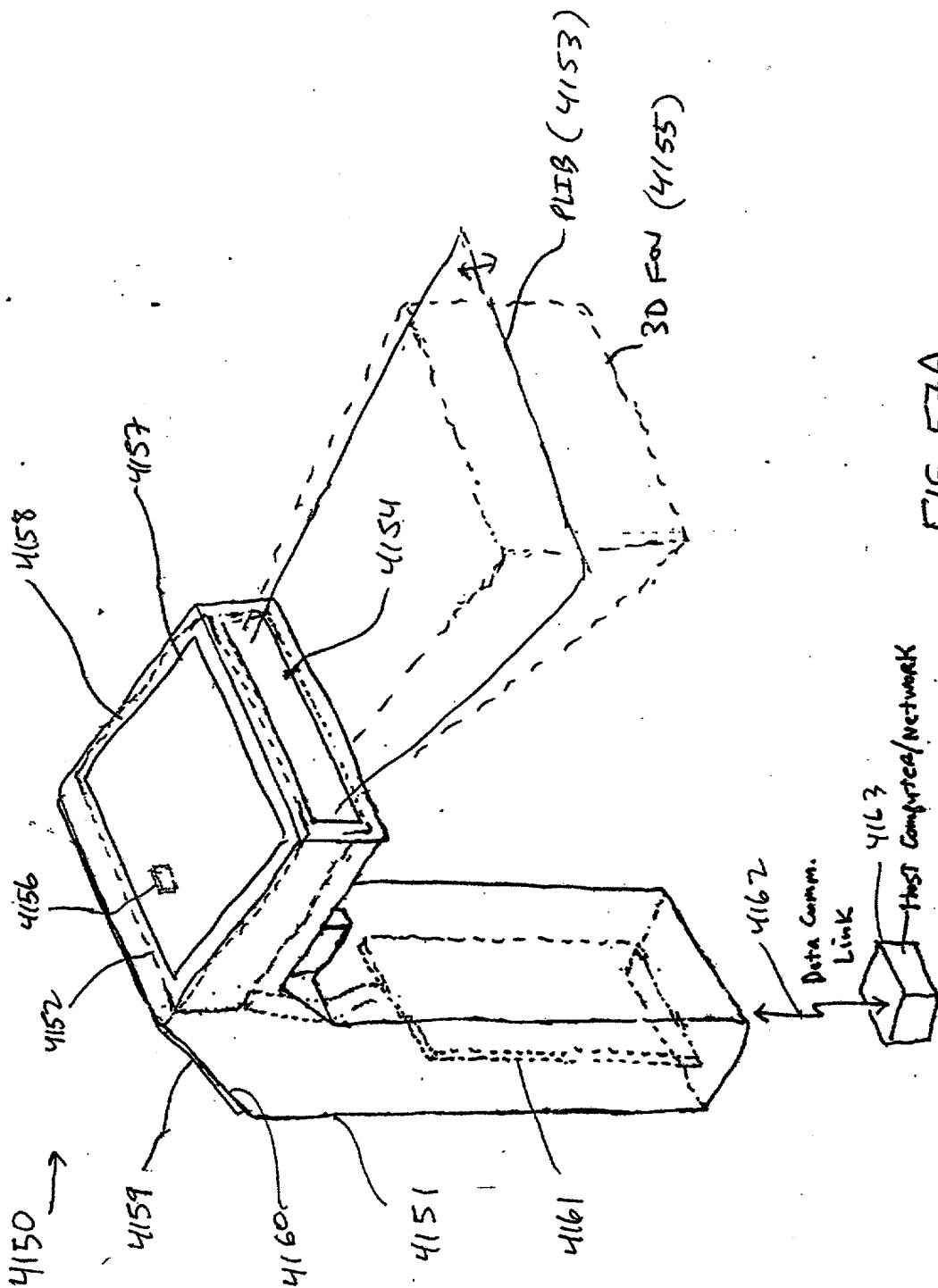


FIG. 57A

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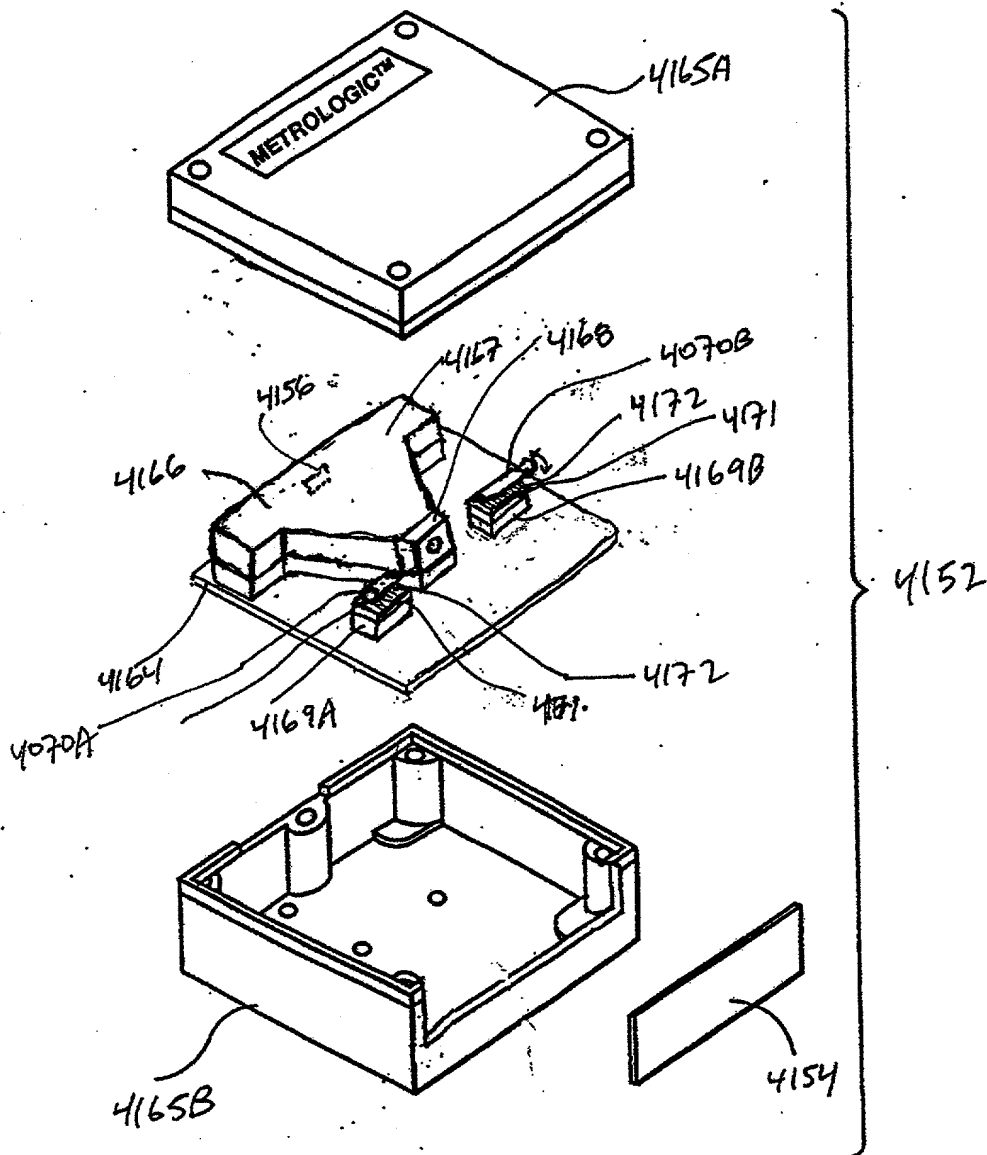
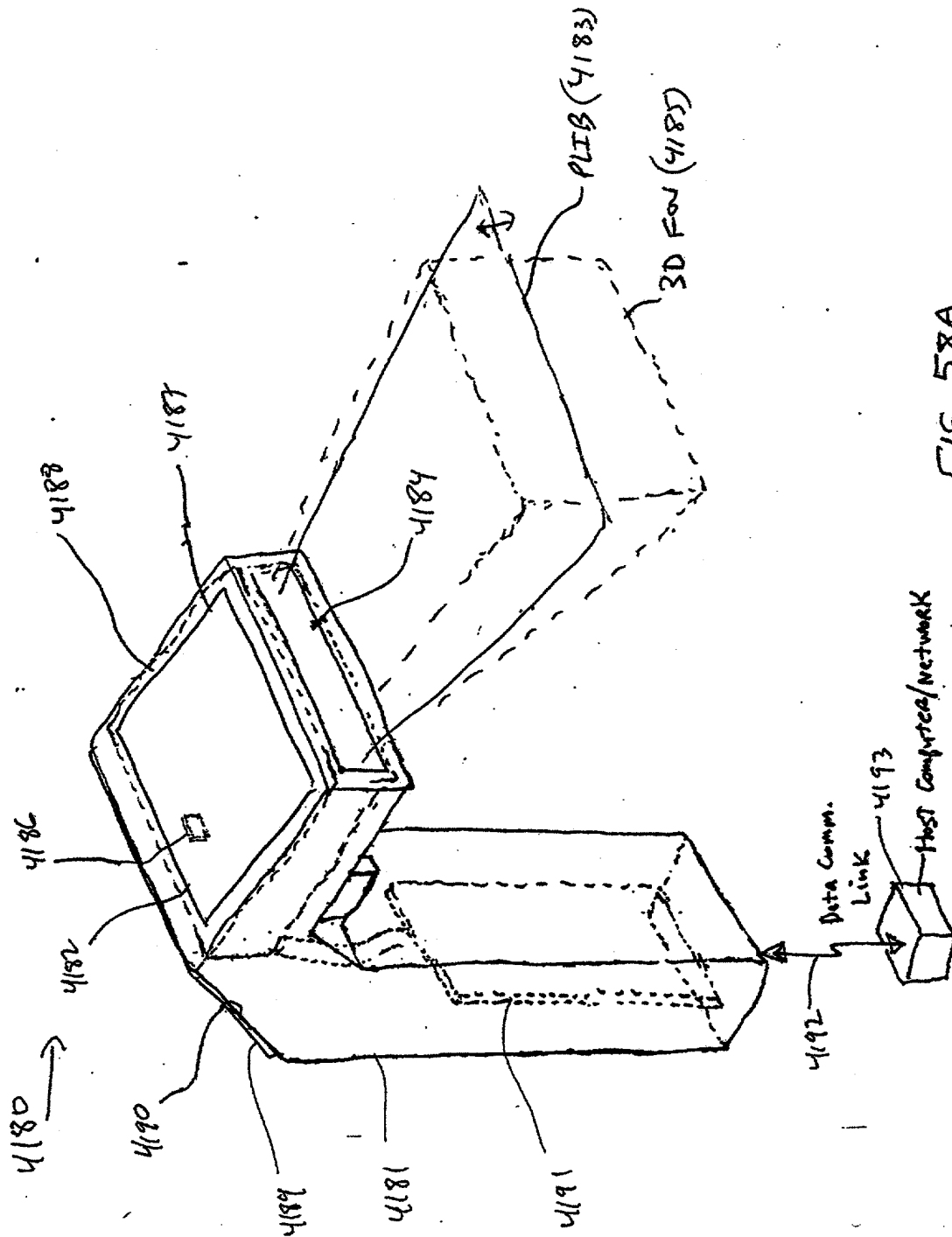


FIG. 57B

Phase only LCR  
pin panel

Figs 178F-86

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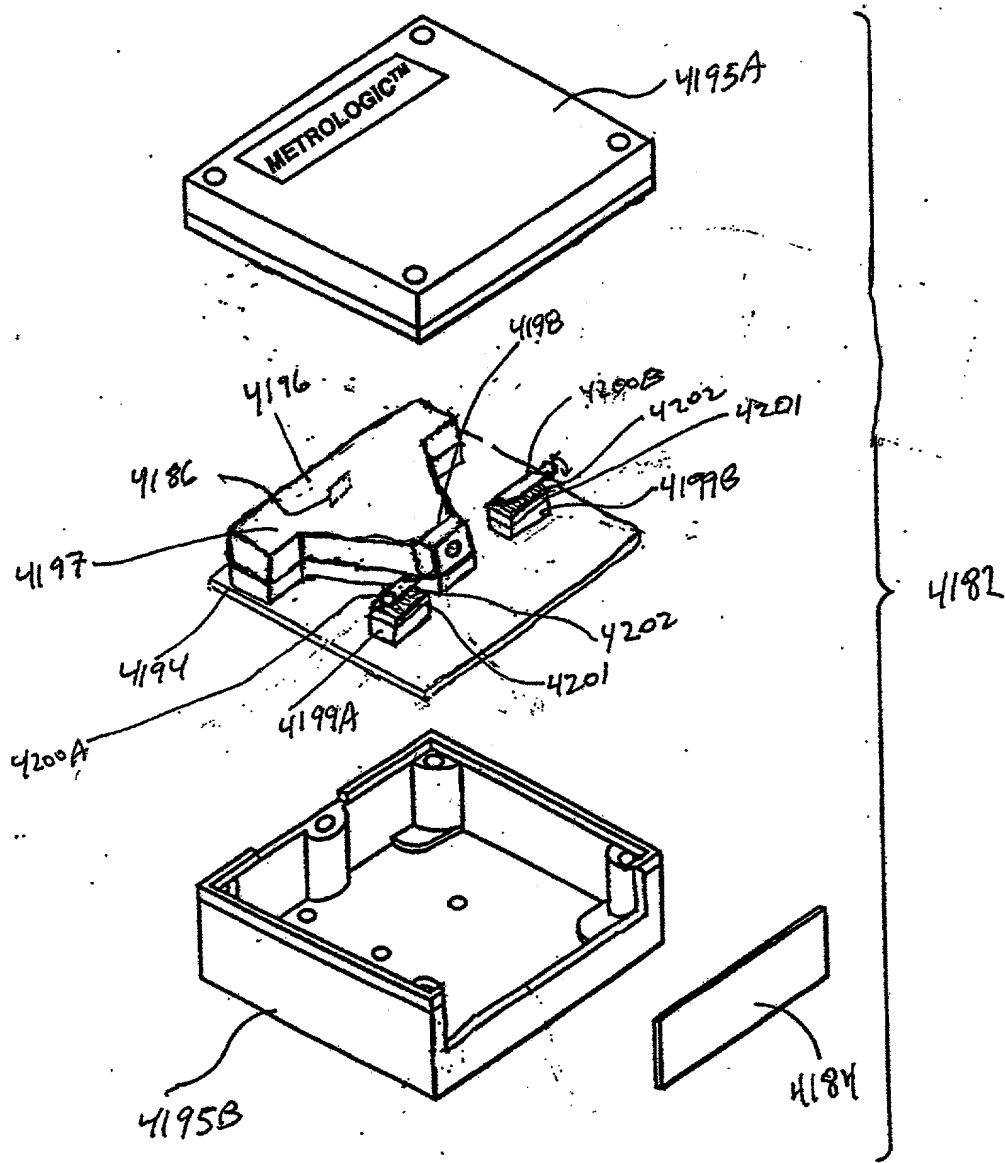


FIG. 58B

115 optical shutter  
Fig. 1F 14A-14B

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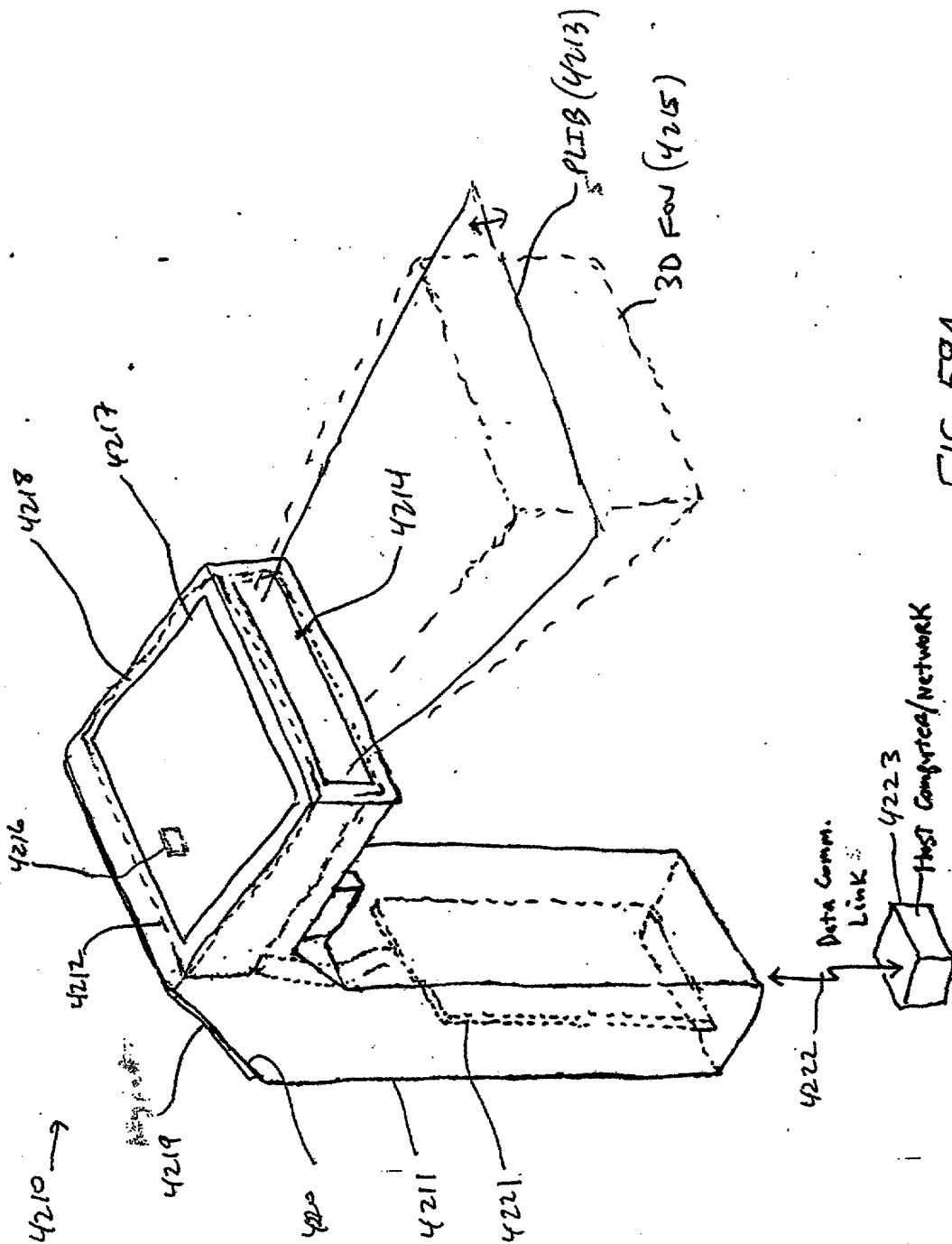


FIG. 59A

202020 294B900T

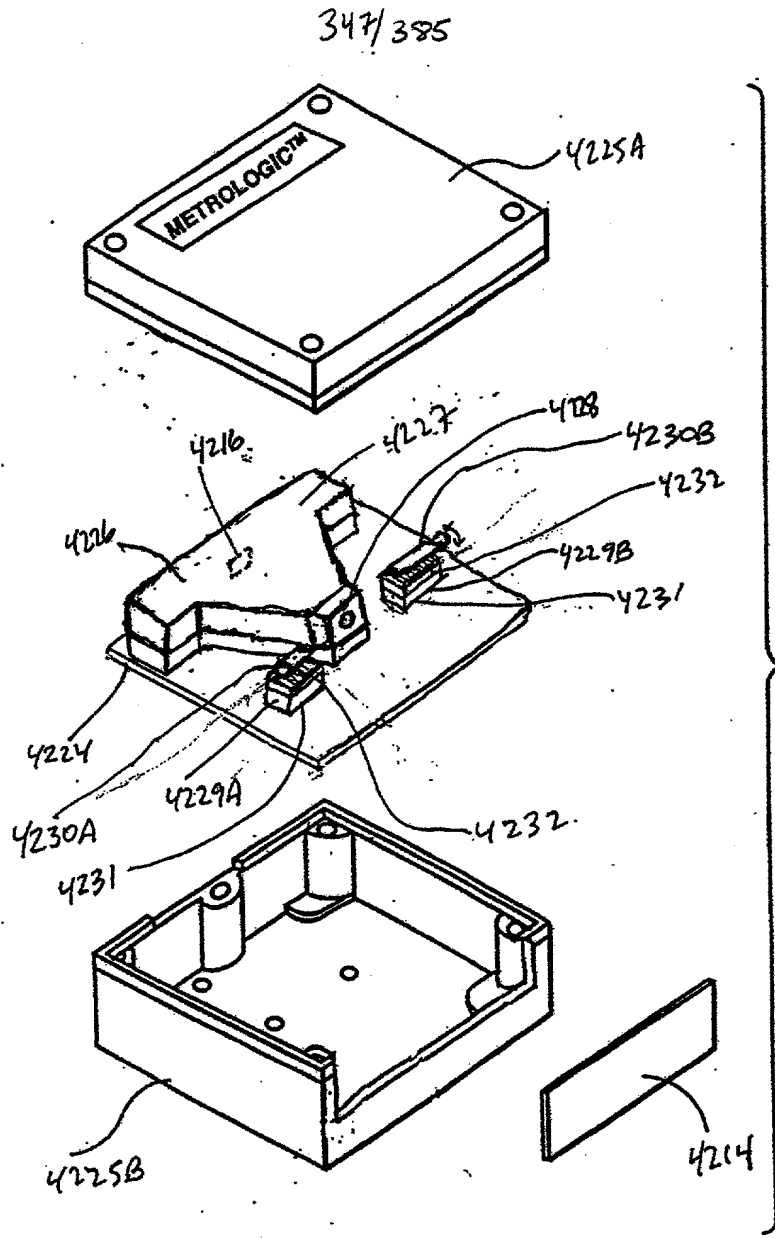


FIG. 59B

MLD  
Fig. 15A-15B

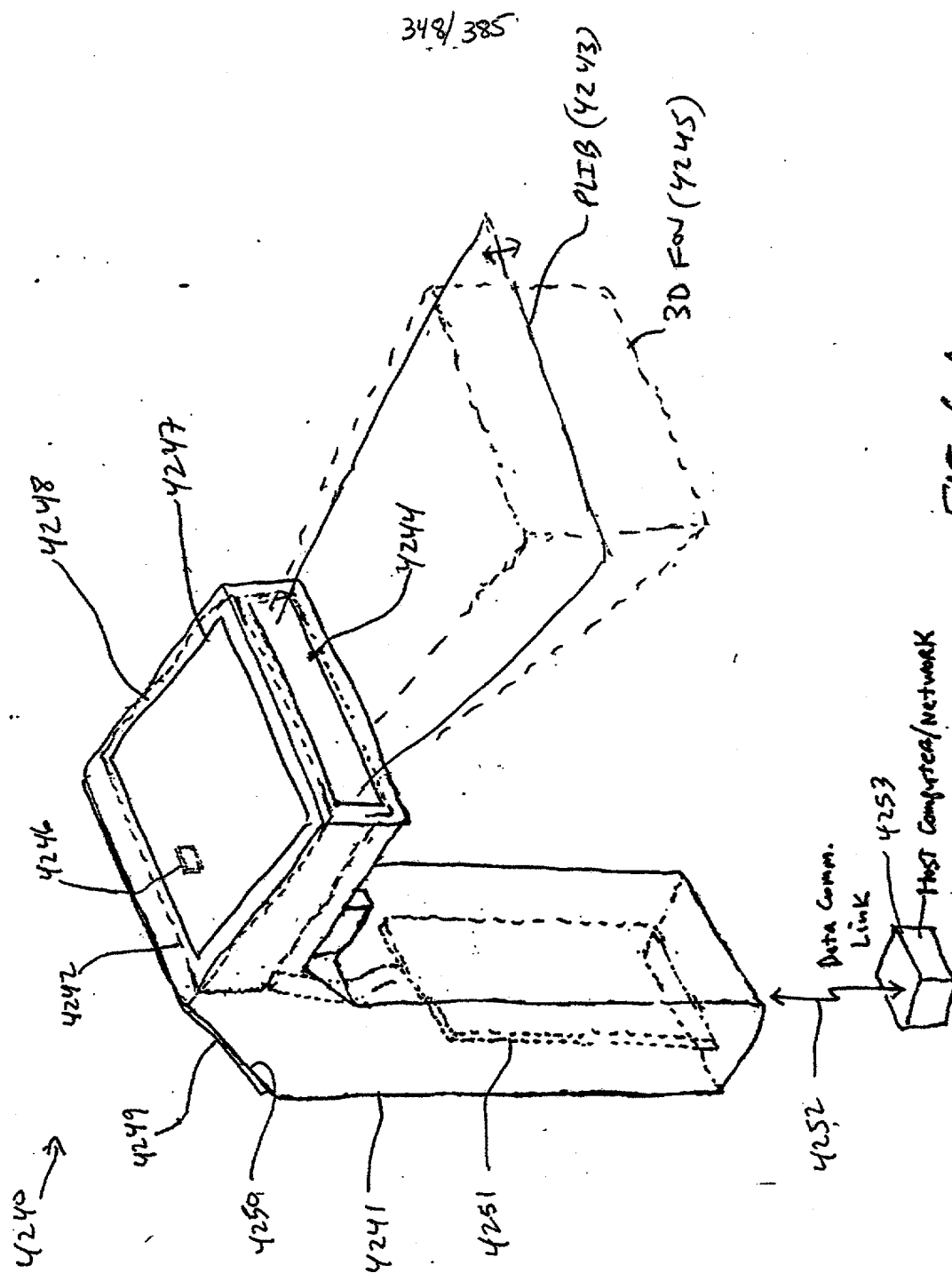


FIG. 60A



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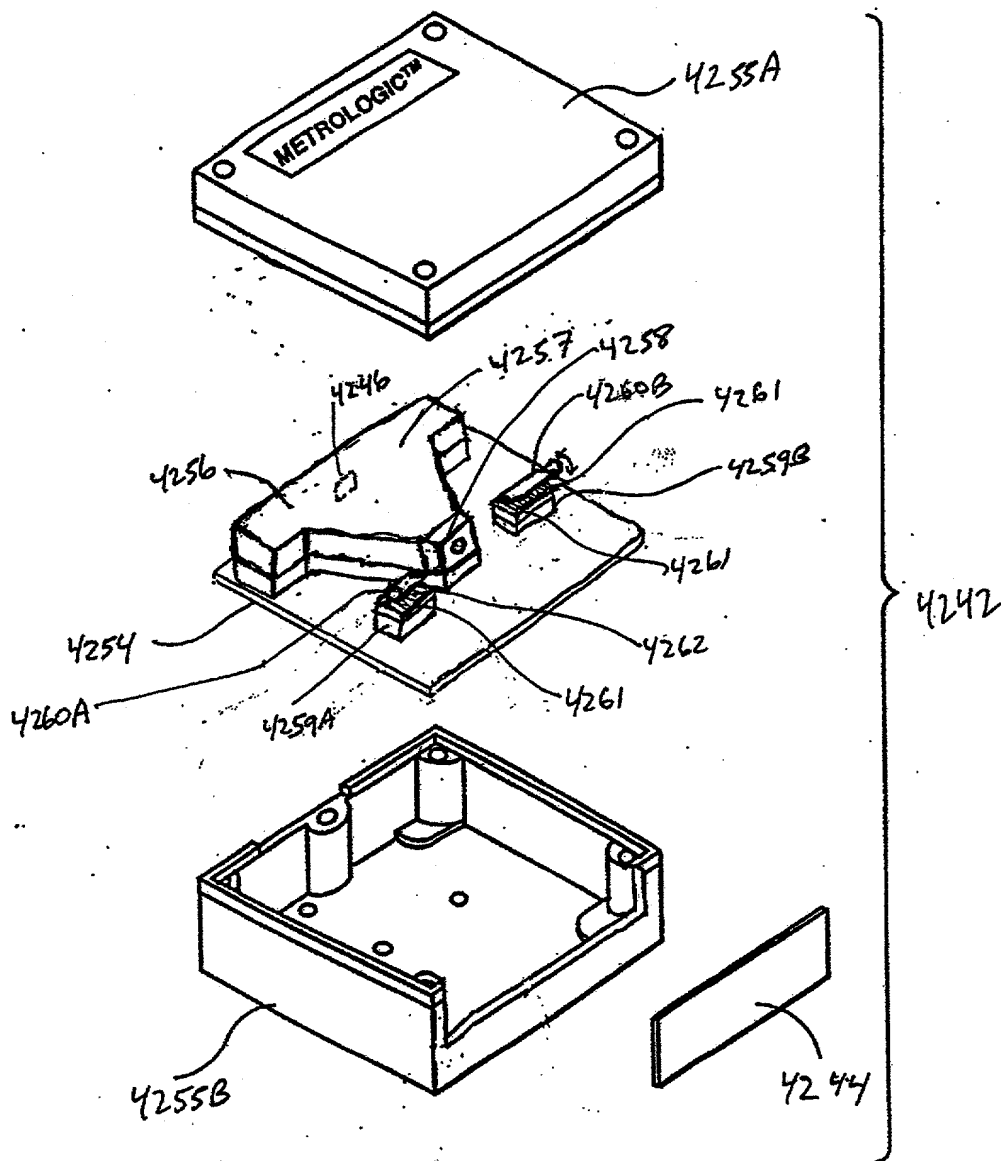


FIG. 60B

Bthalon (Tong. phase mod.)  
Fig. 1 I 17A-17B



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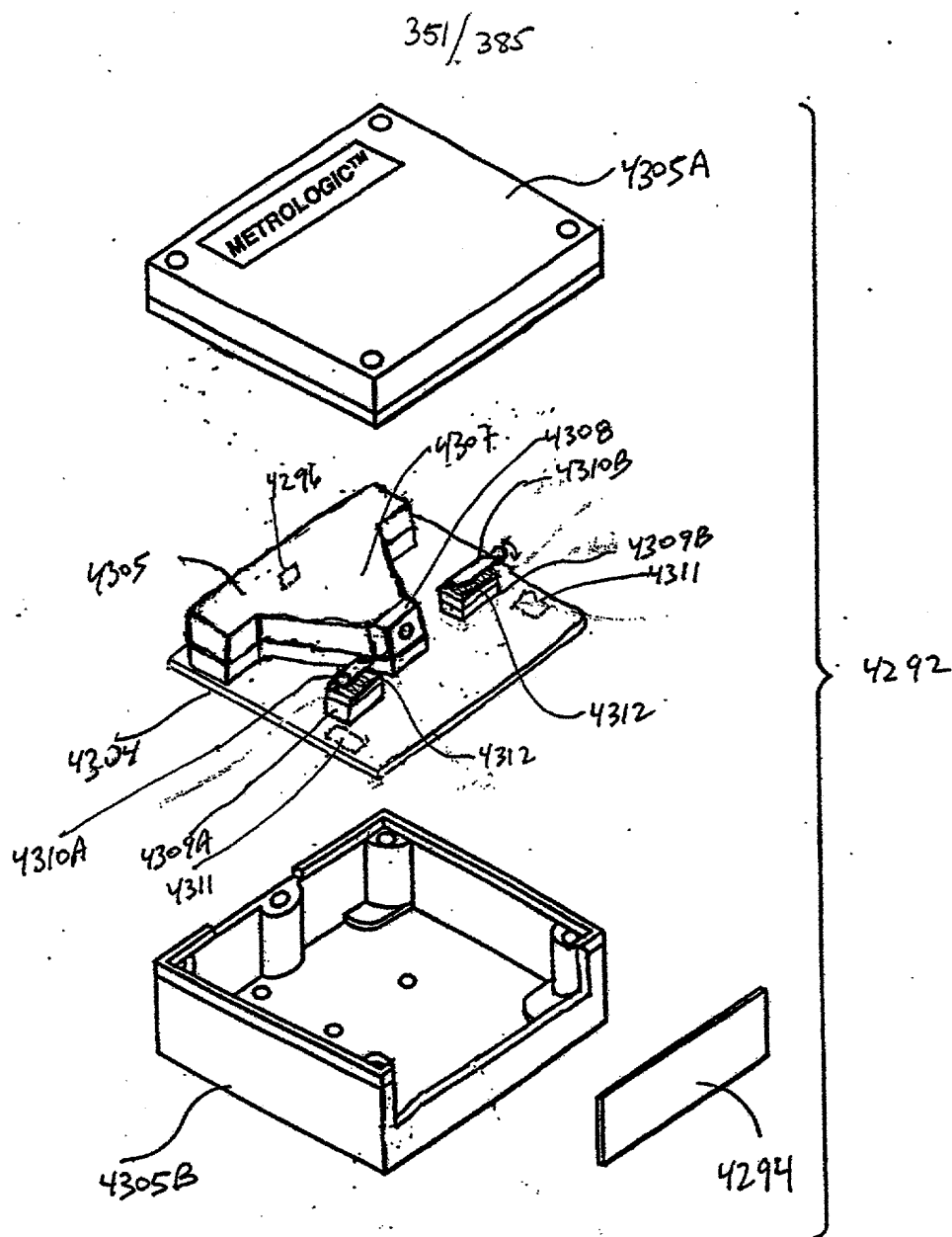


FIG. 61B

Mod. hopping

Fig. 1A-19B

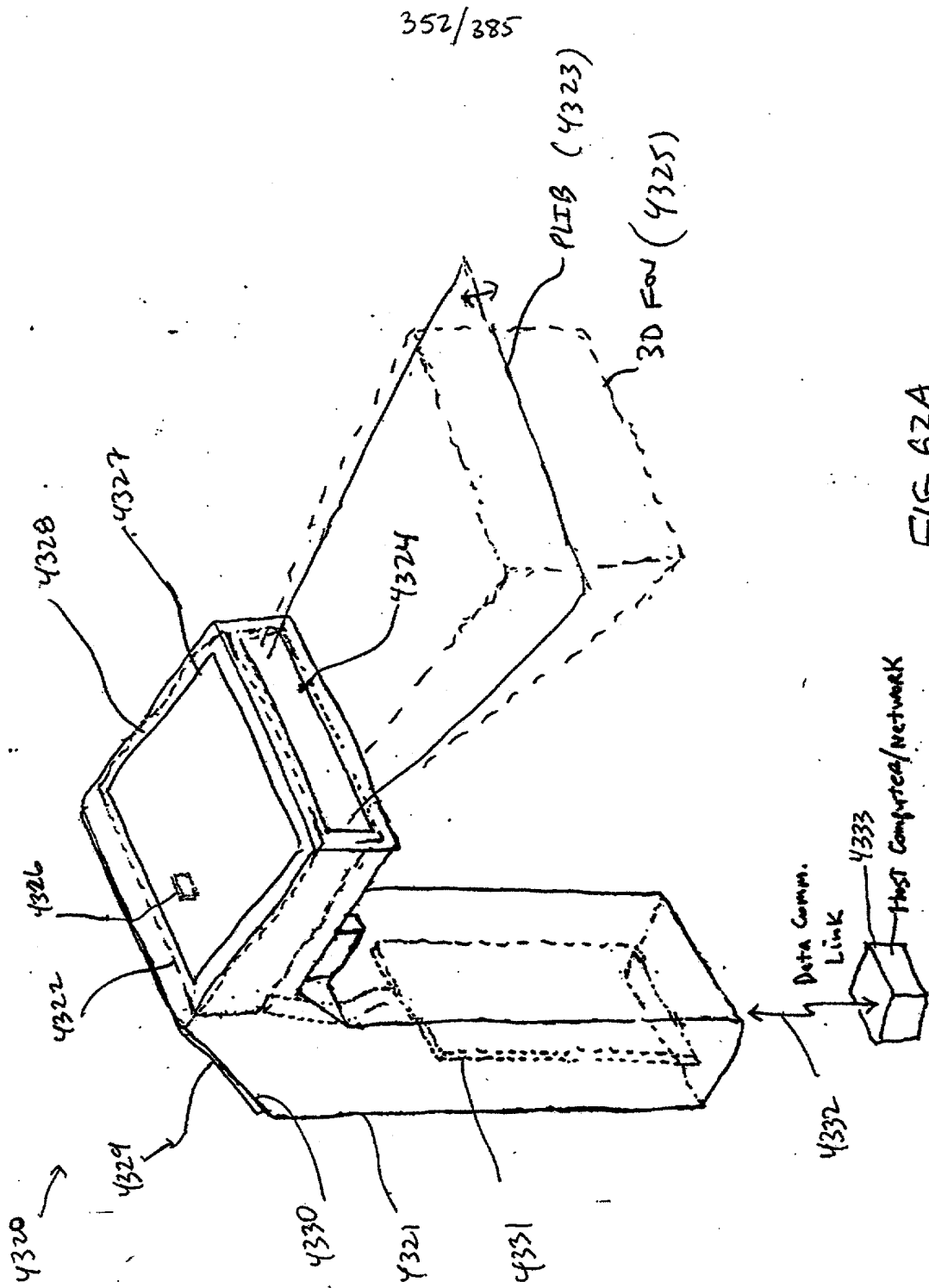


FIG. 62A

202020 29489001

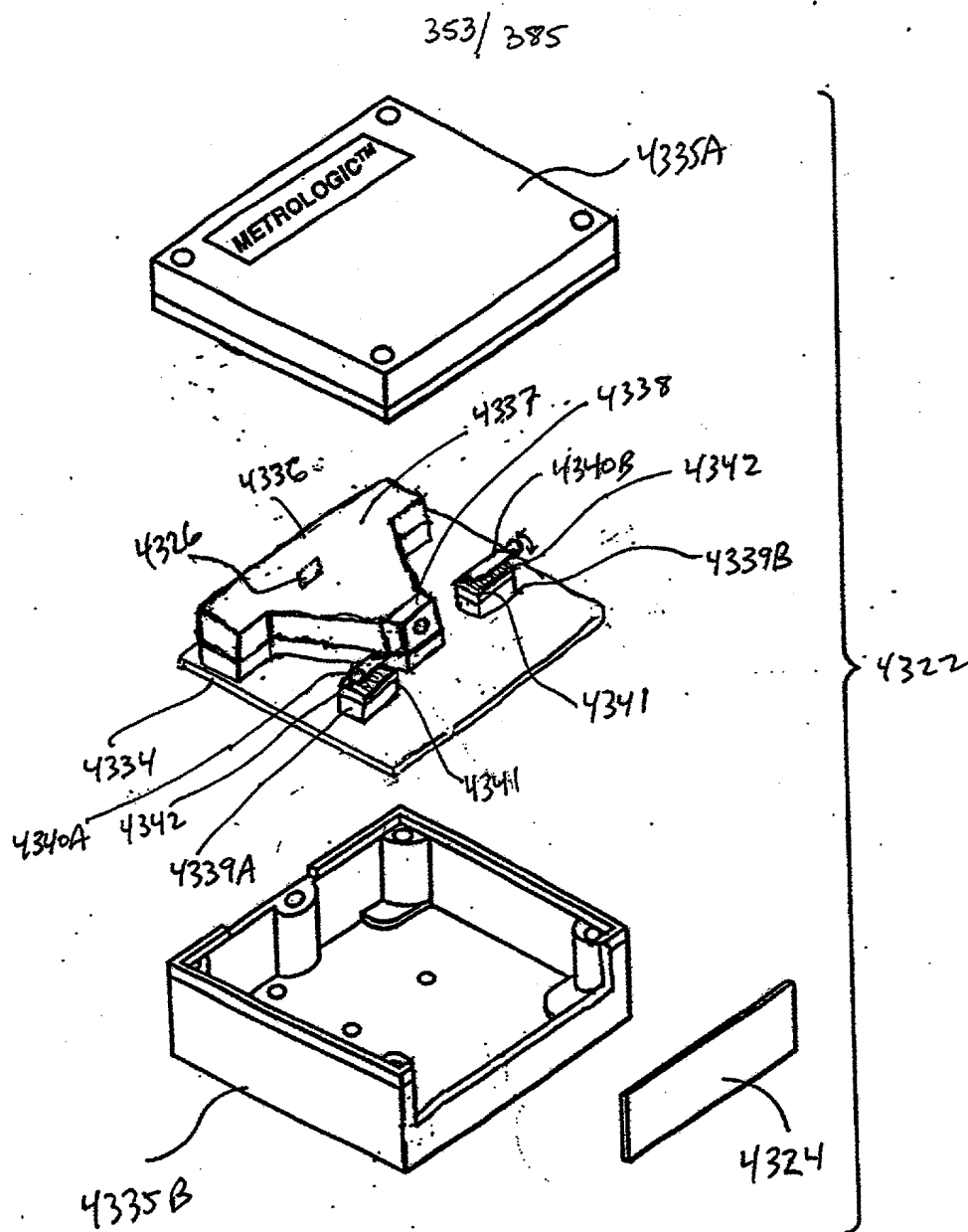


FIG. 62B

measuring  
spot size intensity  
mod. panel

Fig. 1F21A-21D

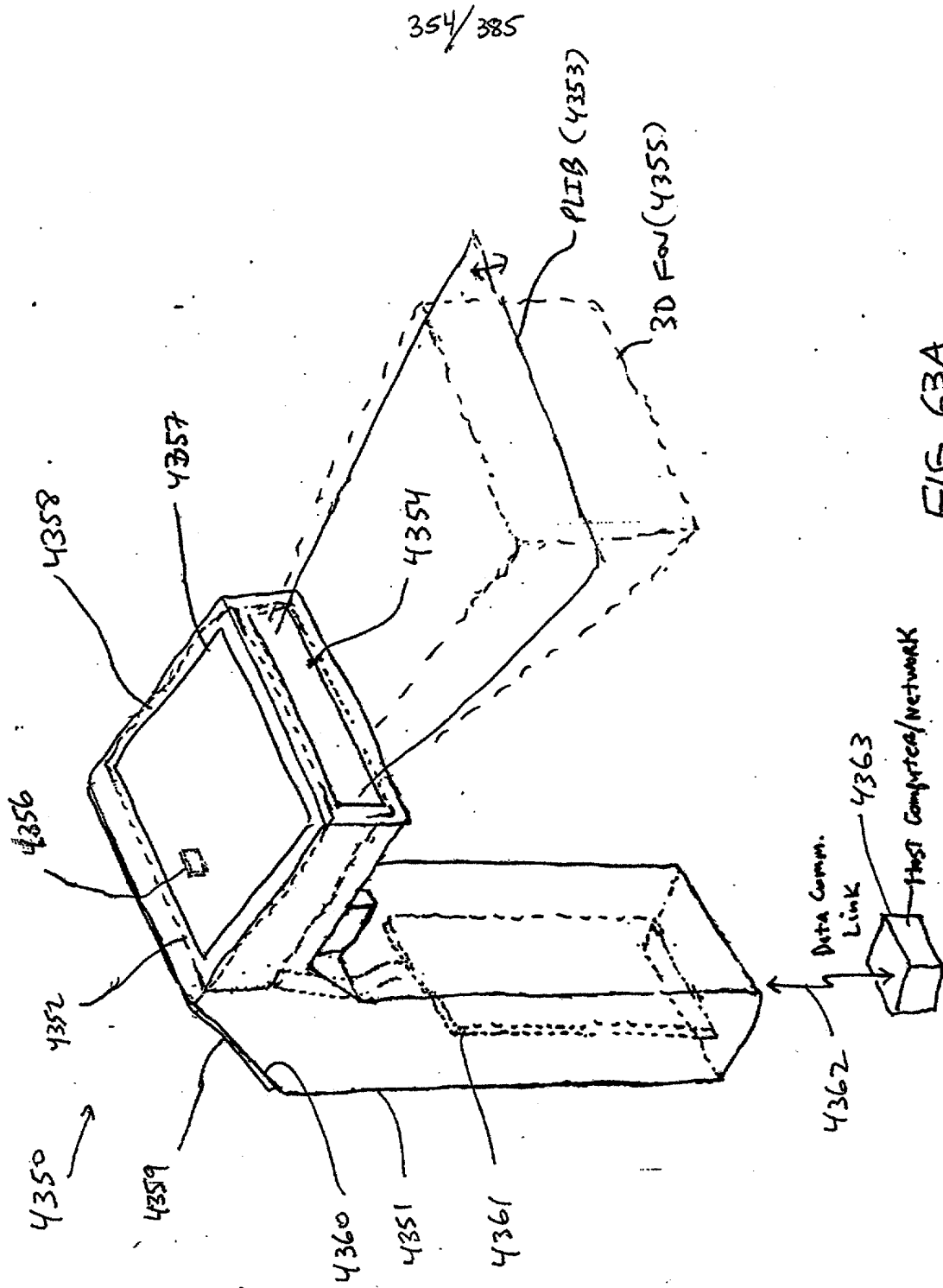


FIG. 63A

1006452.020702

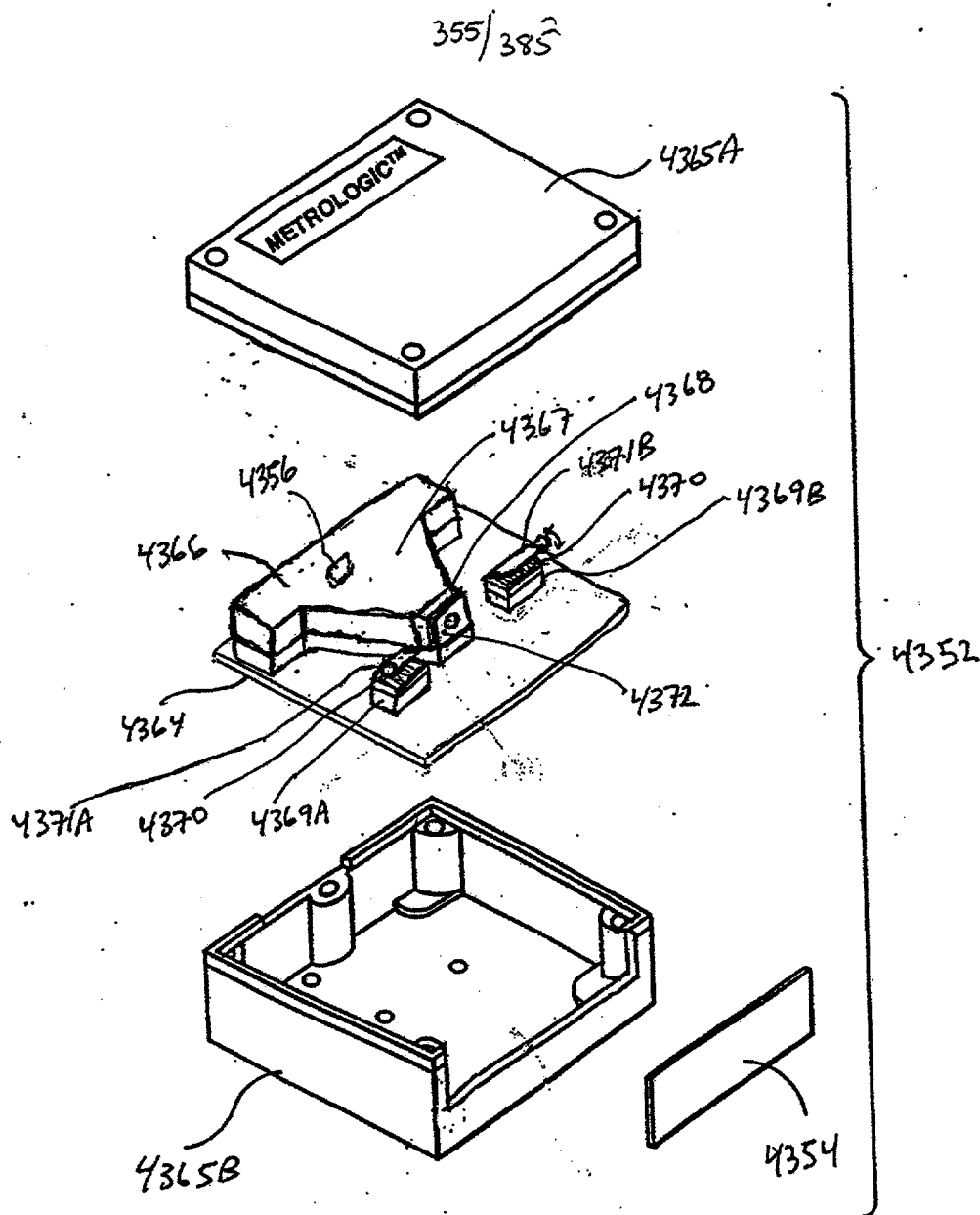


FIG. 63B

Ed. of  
mechanical part of the

Fig. 1<sup>st</sup> 23A-23B

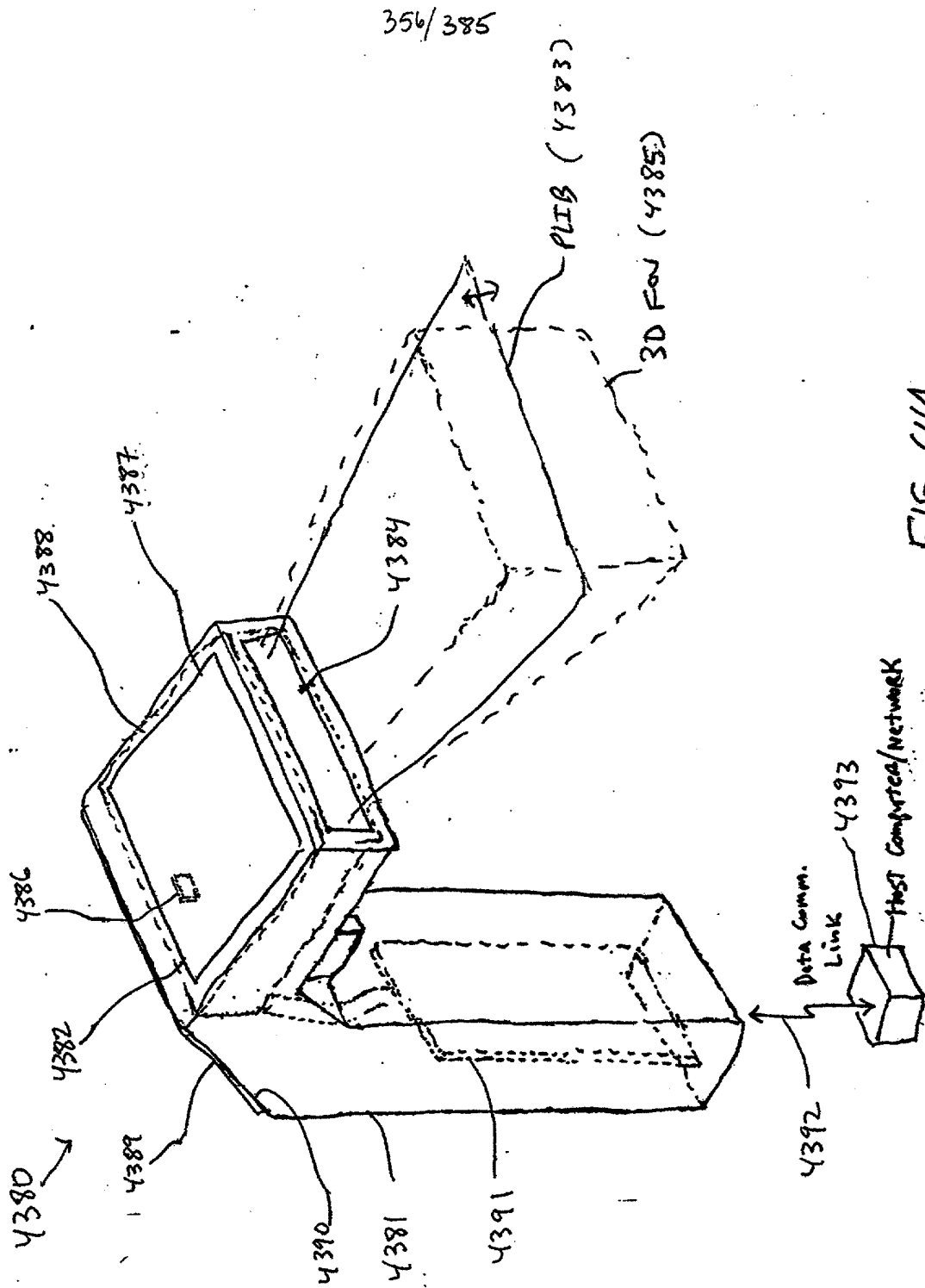


FIG. 64A



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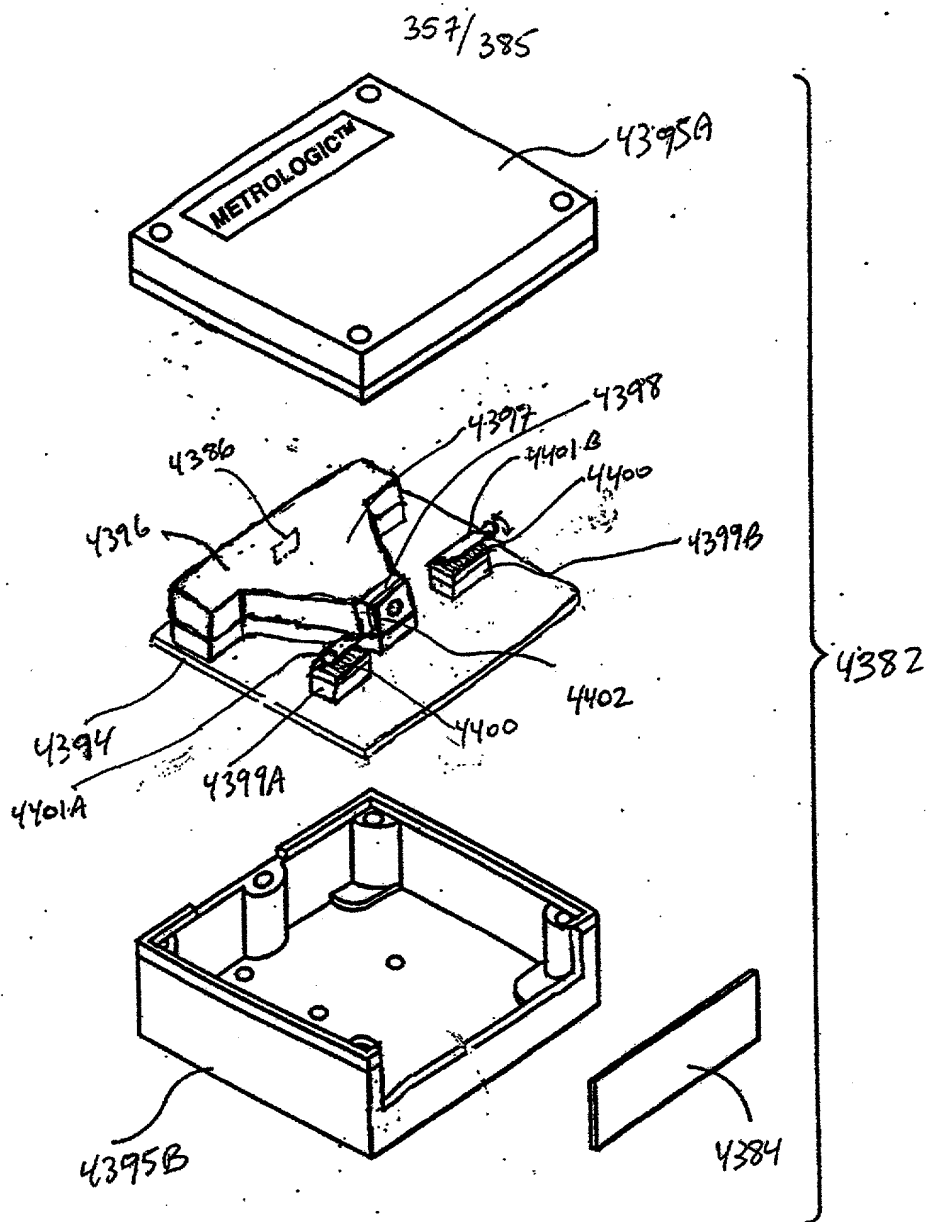


FIG. 64B

\* E-optical  
Shutter before  
EP Lens  
Fig. 1224A

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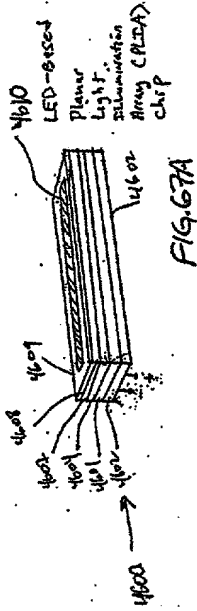


FIG. 67A

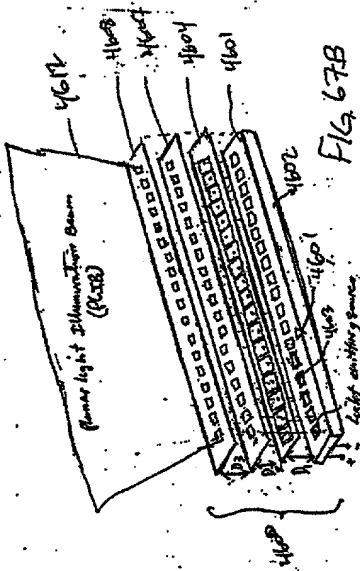


FIG. 67B

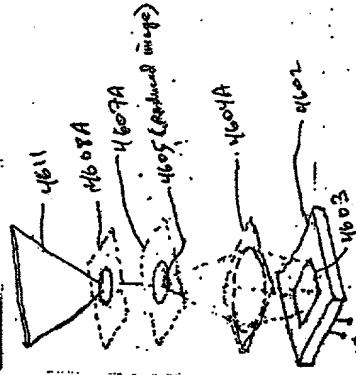


FIG. 67C

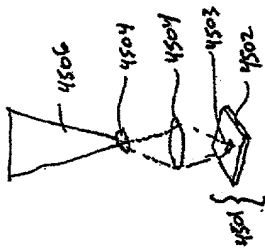


FIG. 65B

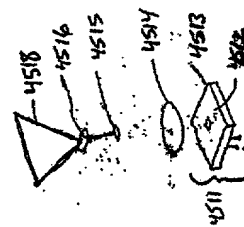


FIG. 66B

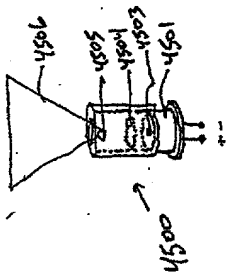


FIG. 65A

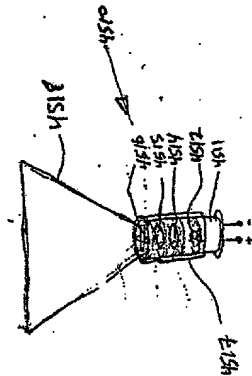
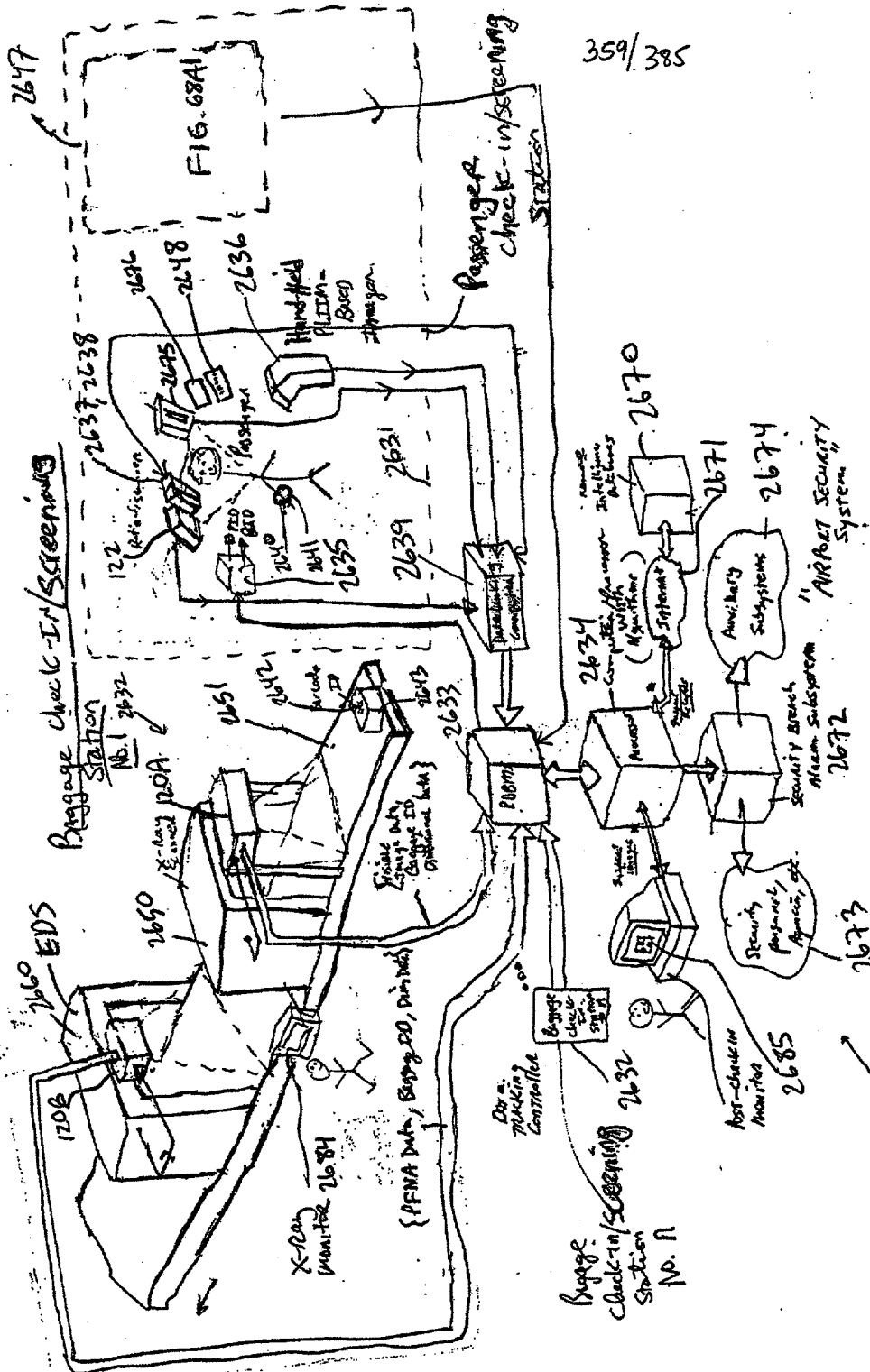


FIG. 66A



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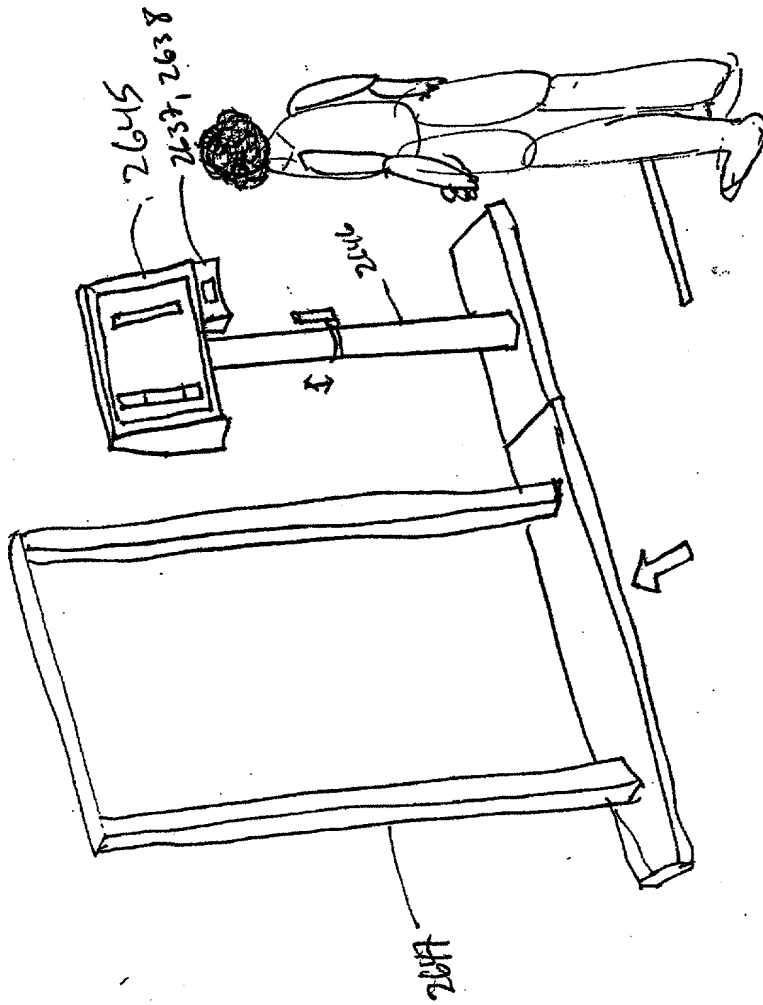
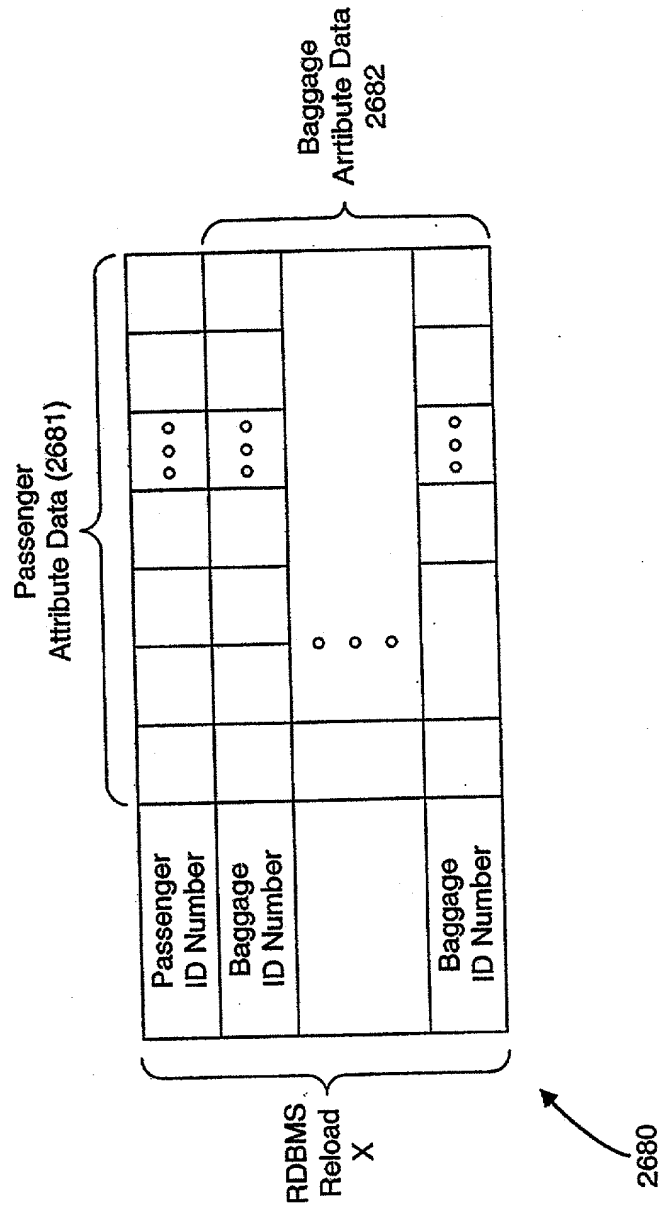


FIG. 68A



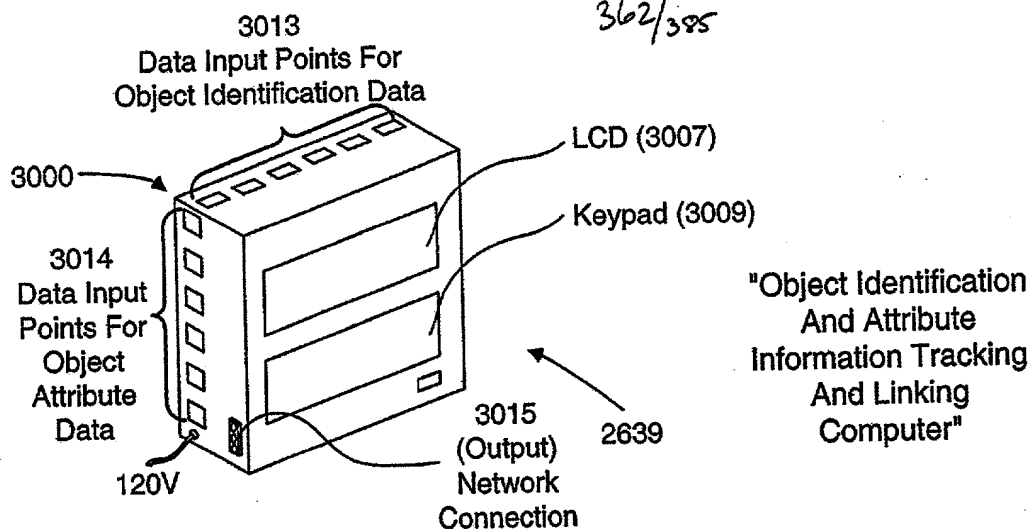


FIG. 68C1

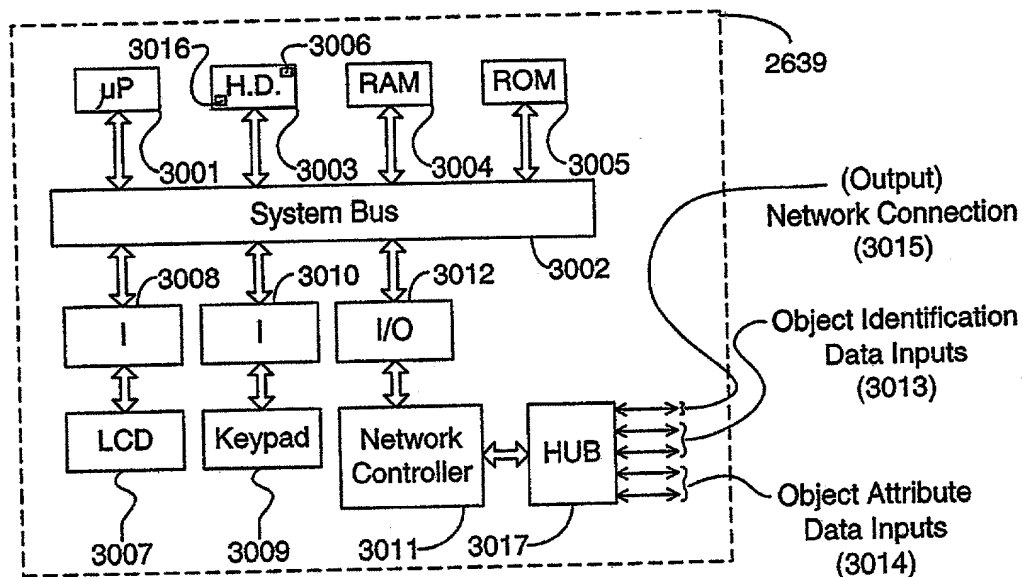


FIG. 68C2

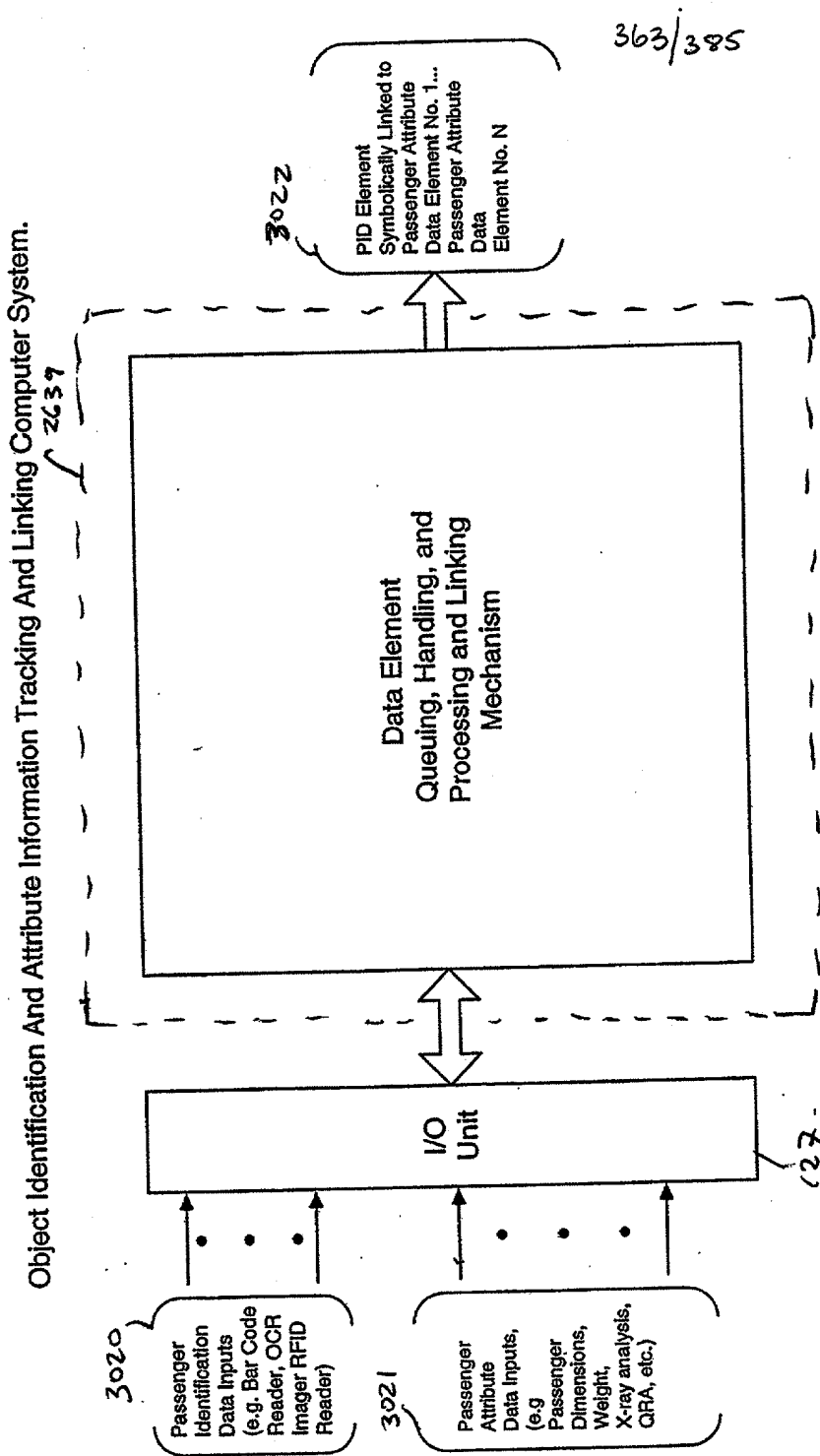


FIG. 68C3





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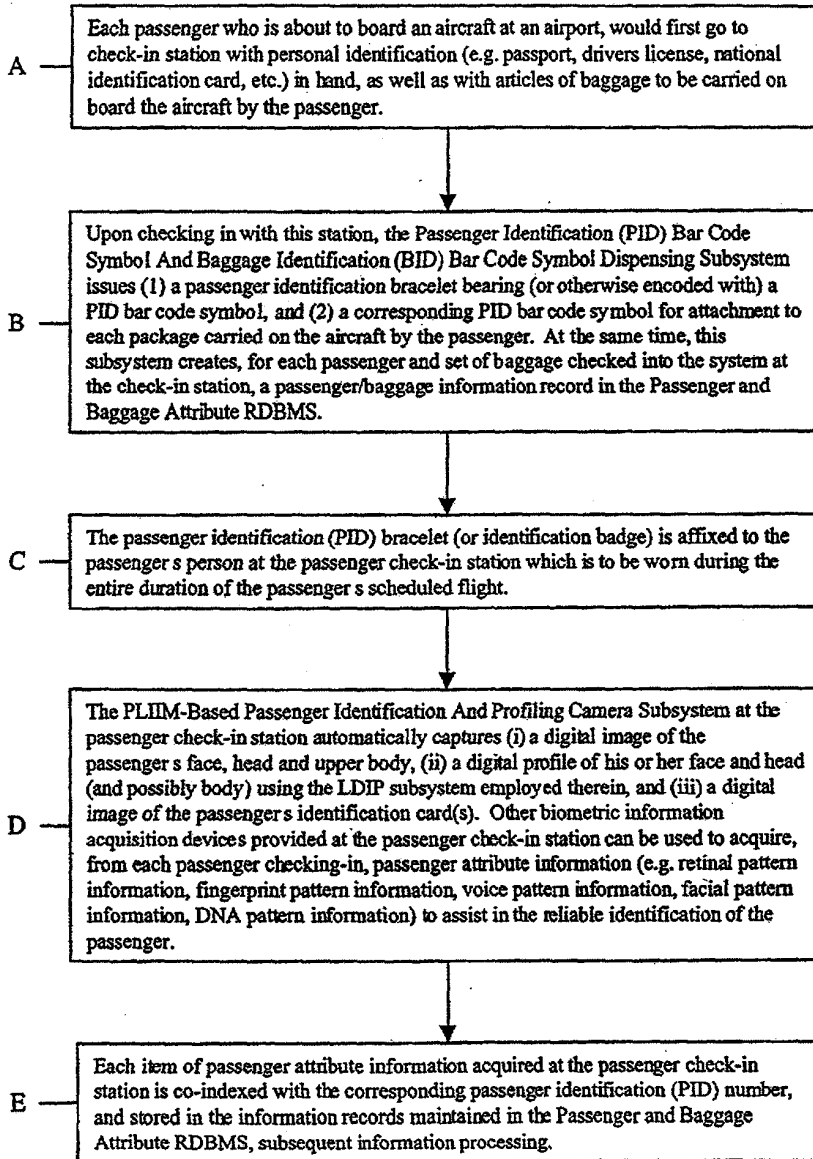


FIG. 68D1

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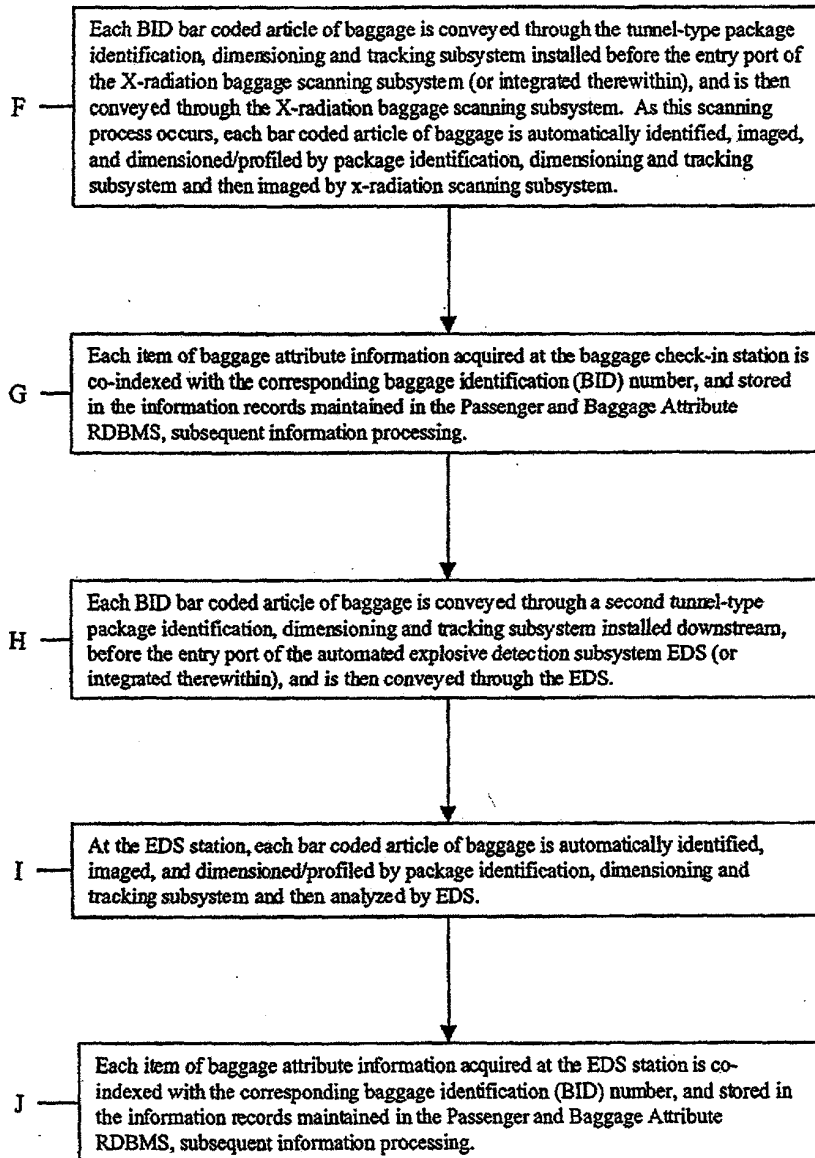


FIG. 68D2

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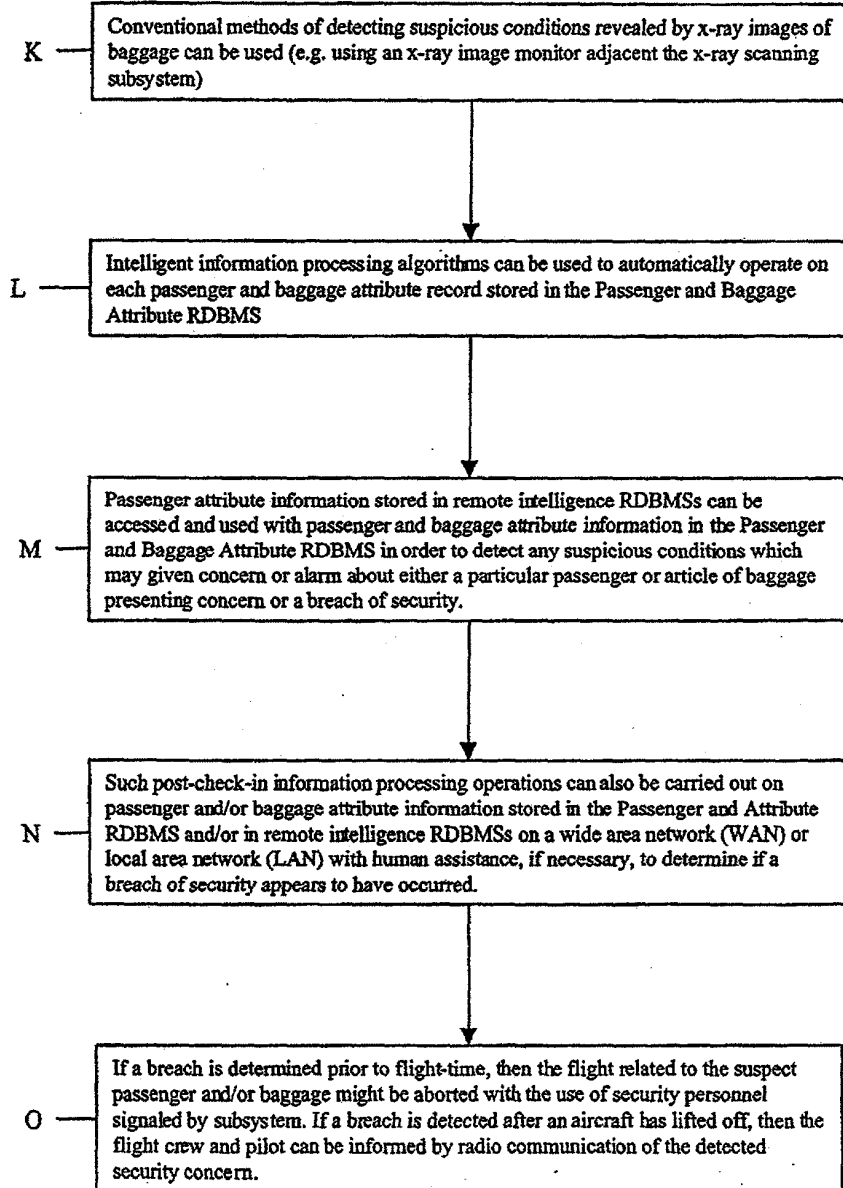


FIG. 68D3

**1069-87**

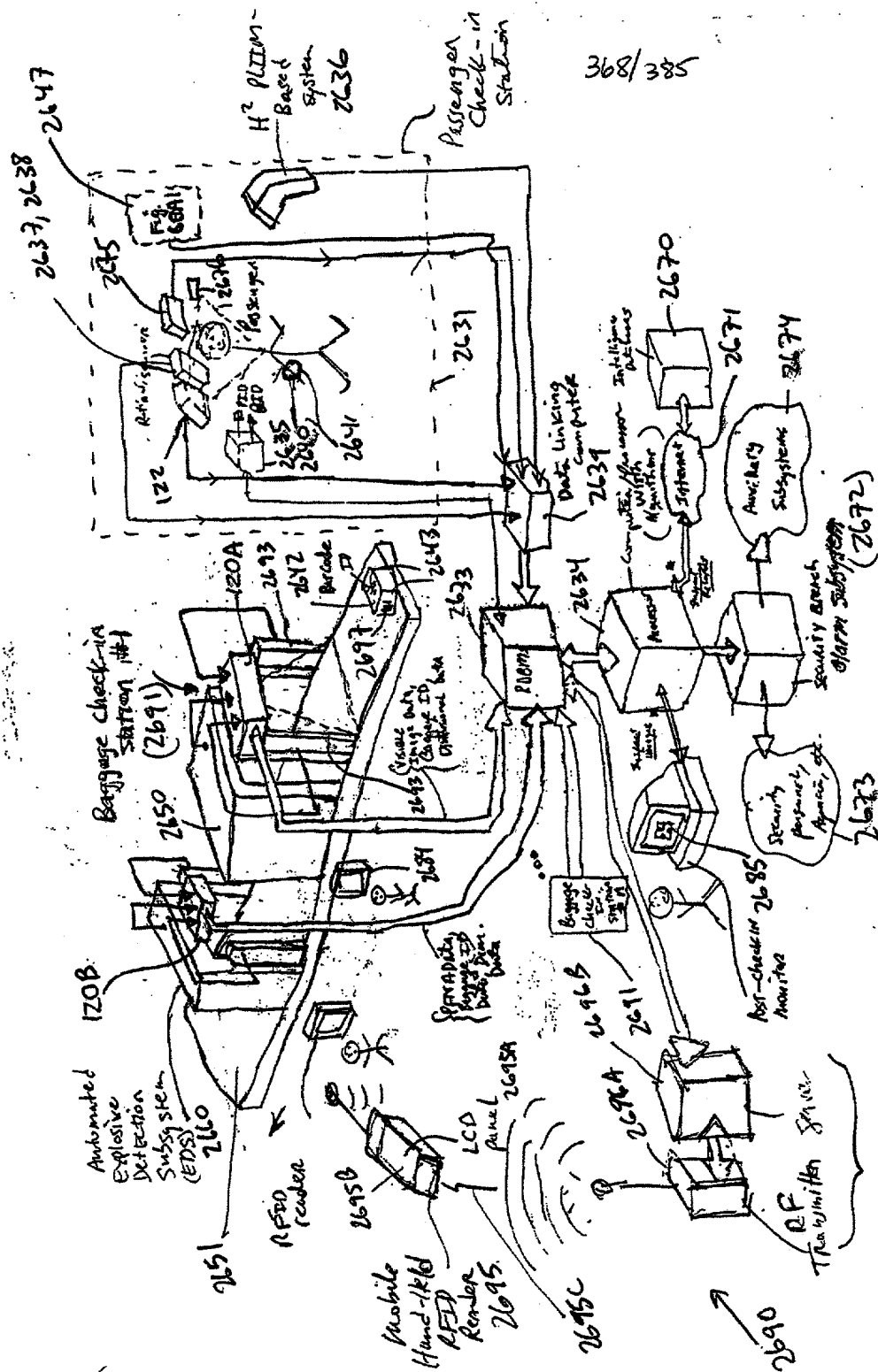


FIG. 69A

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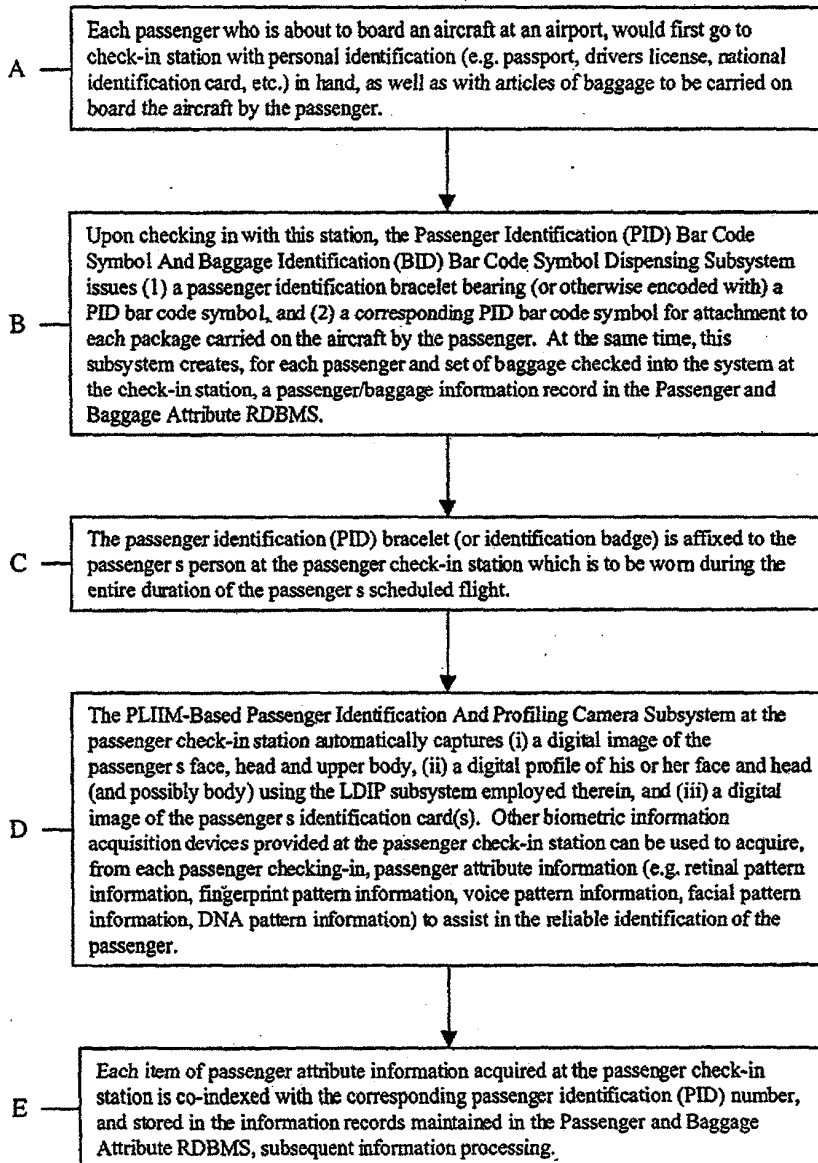


FIG. 69B1

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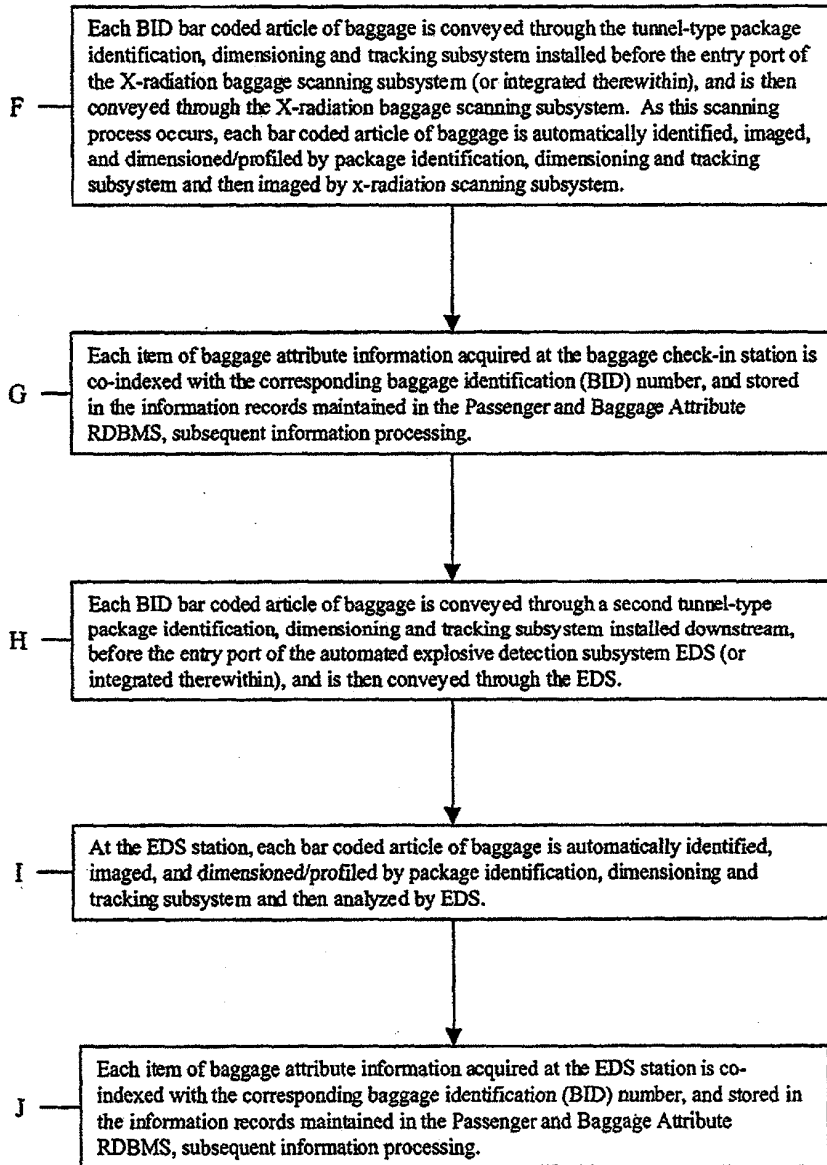


FIG. 69B2

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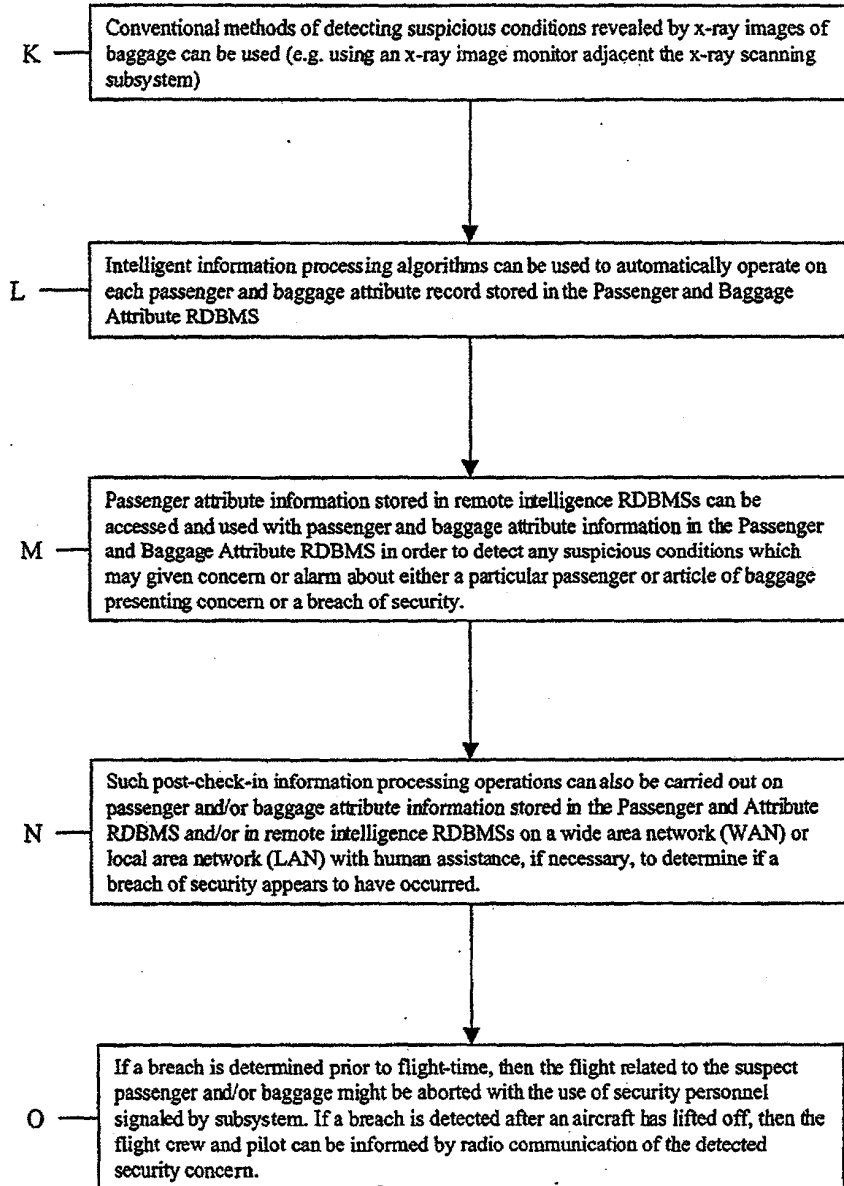
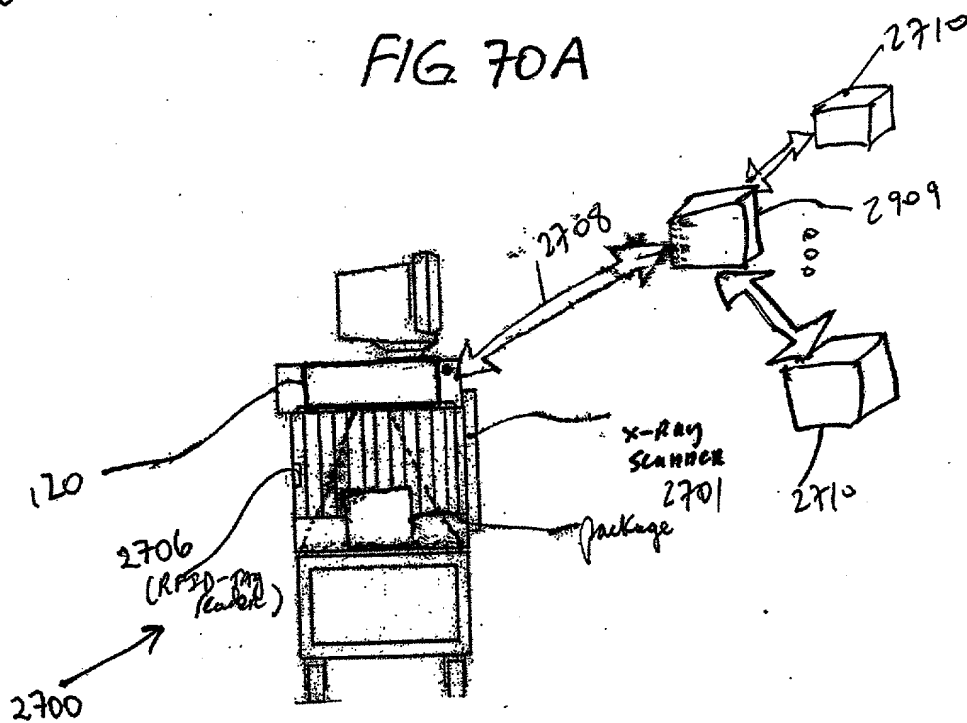
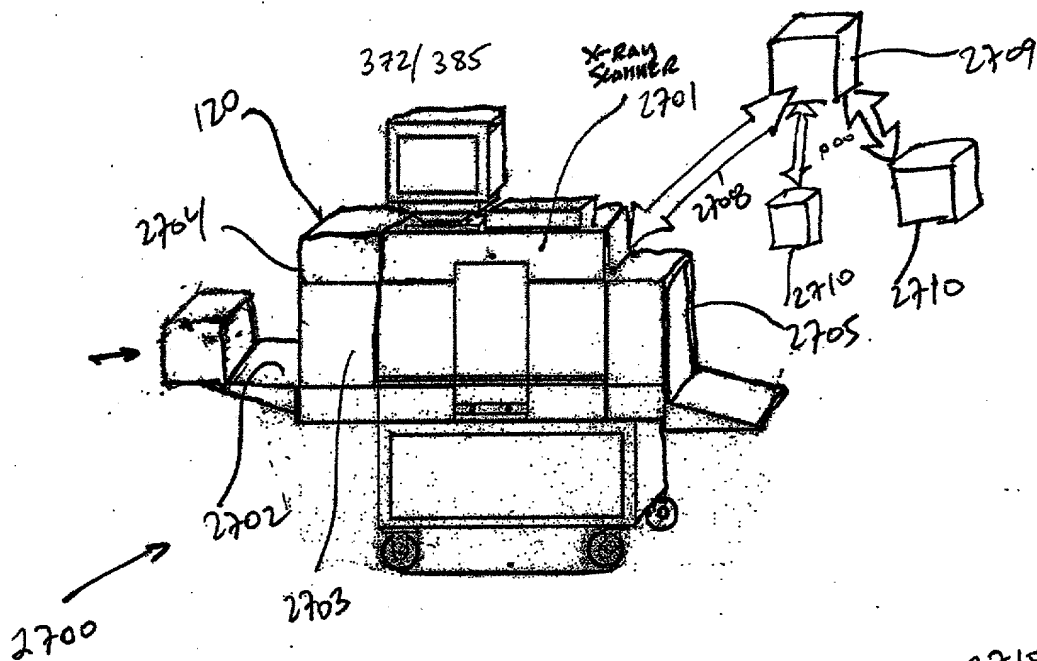


FIG. 69B3





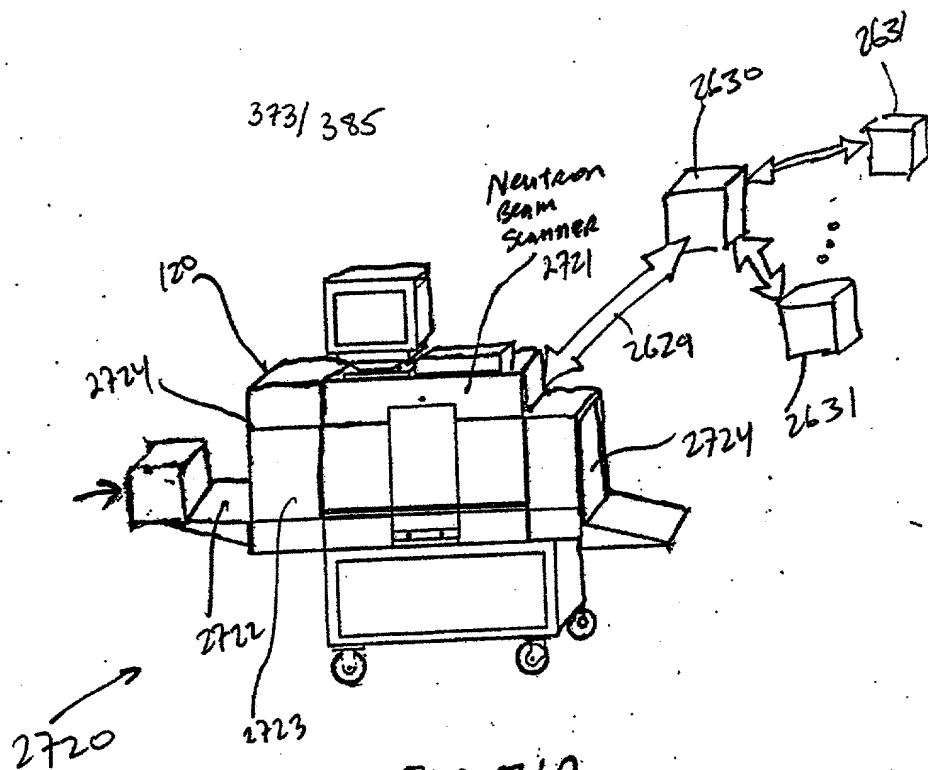


FIG 71A

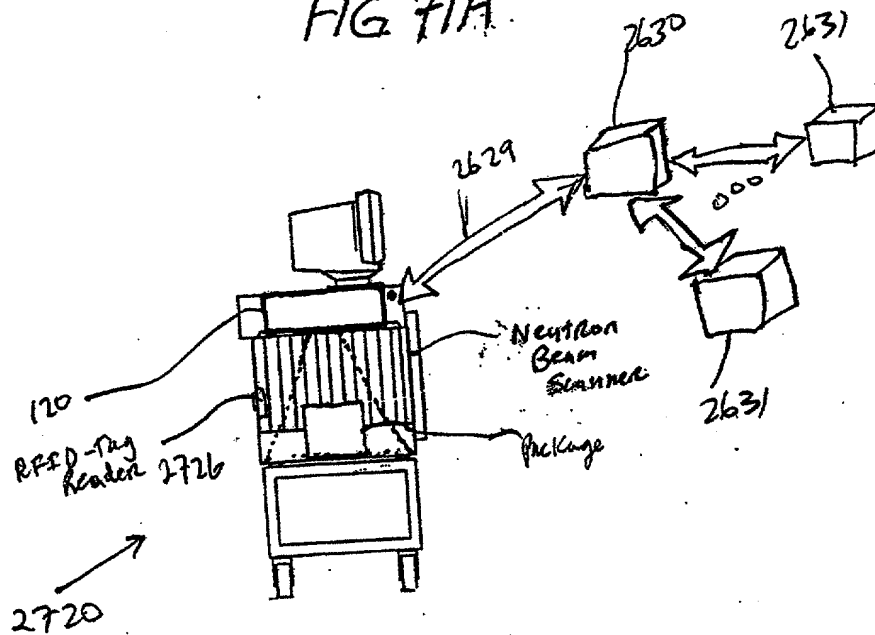


FIG 71B

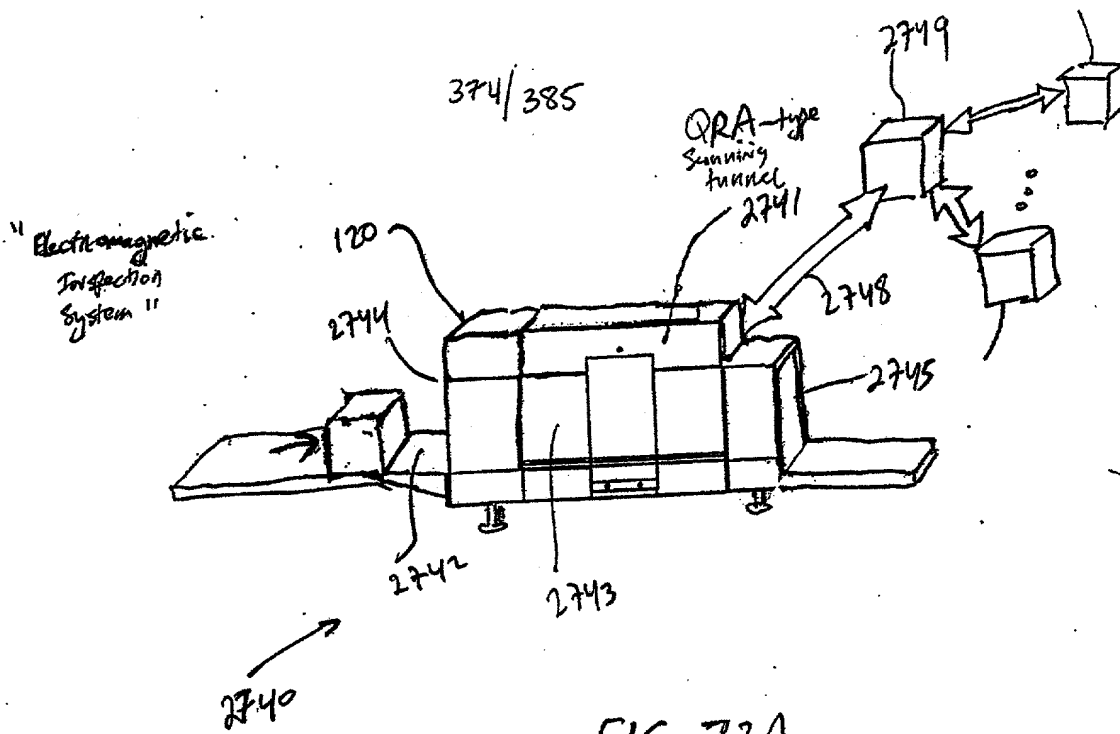


FIG 72A

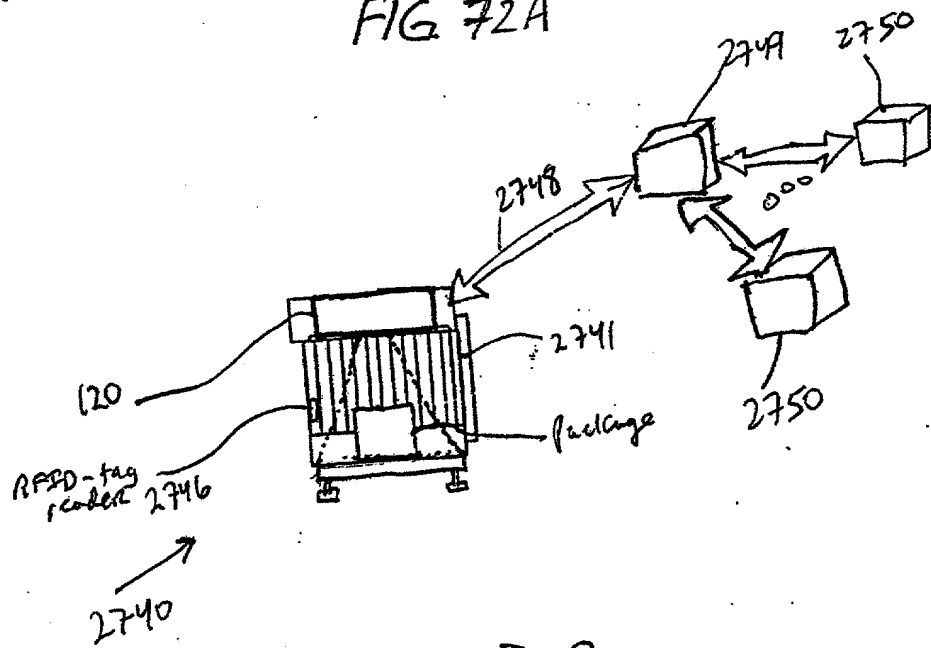


FIG 72B

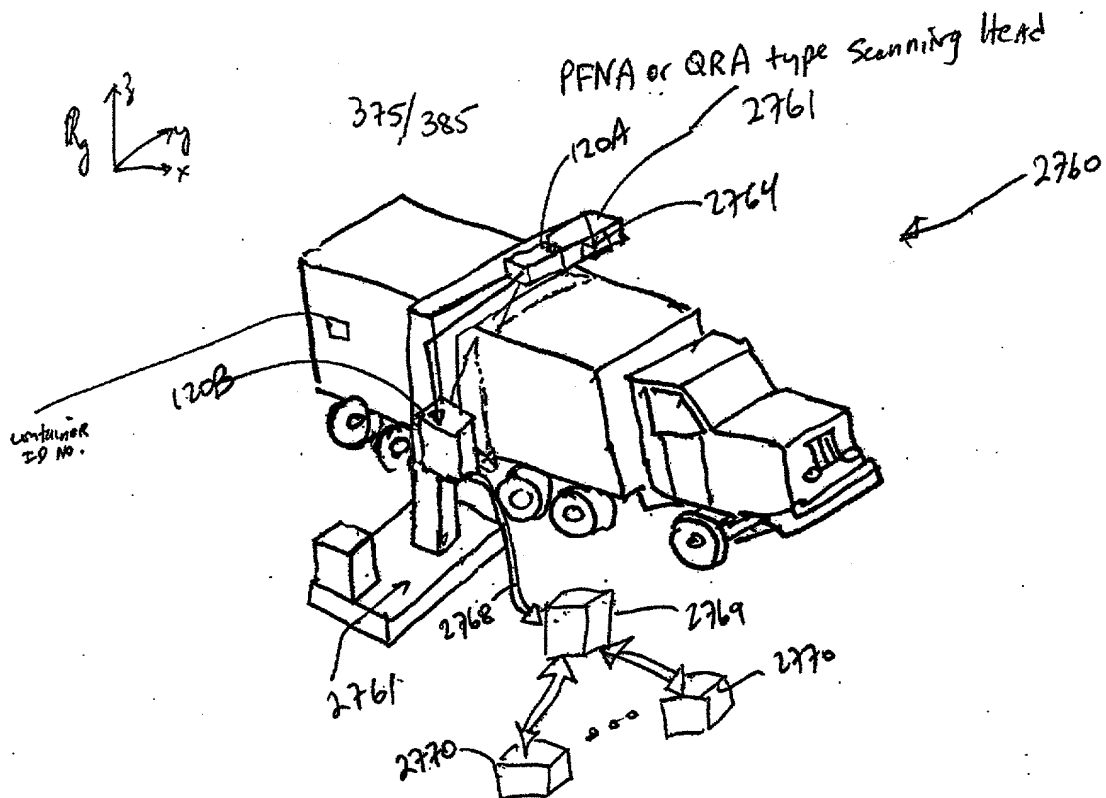


FIG. 73

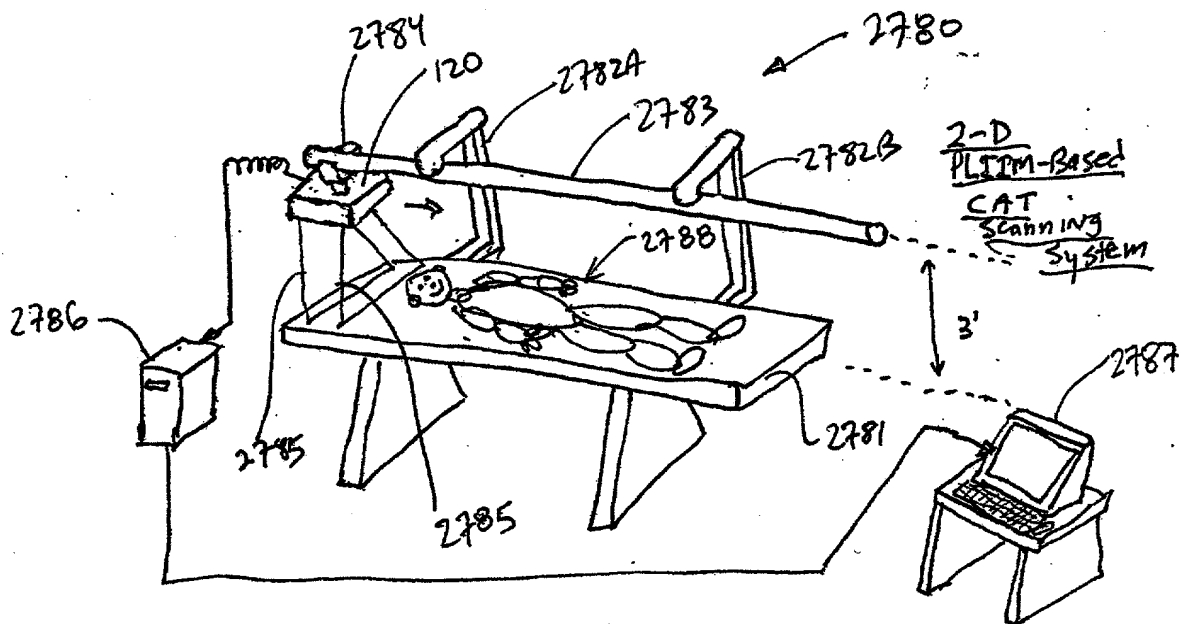
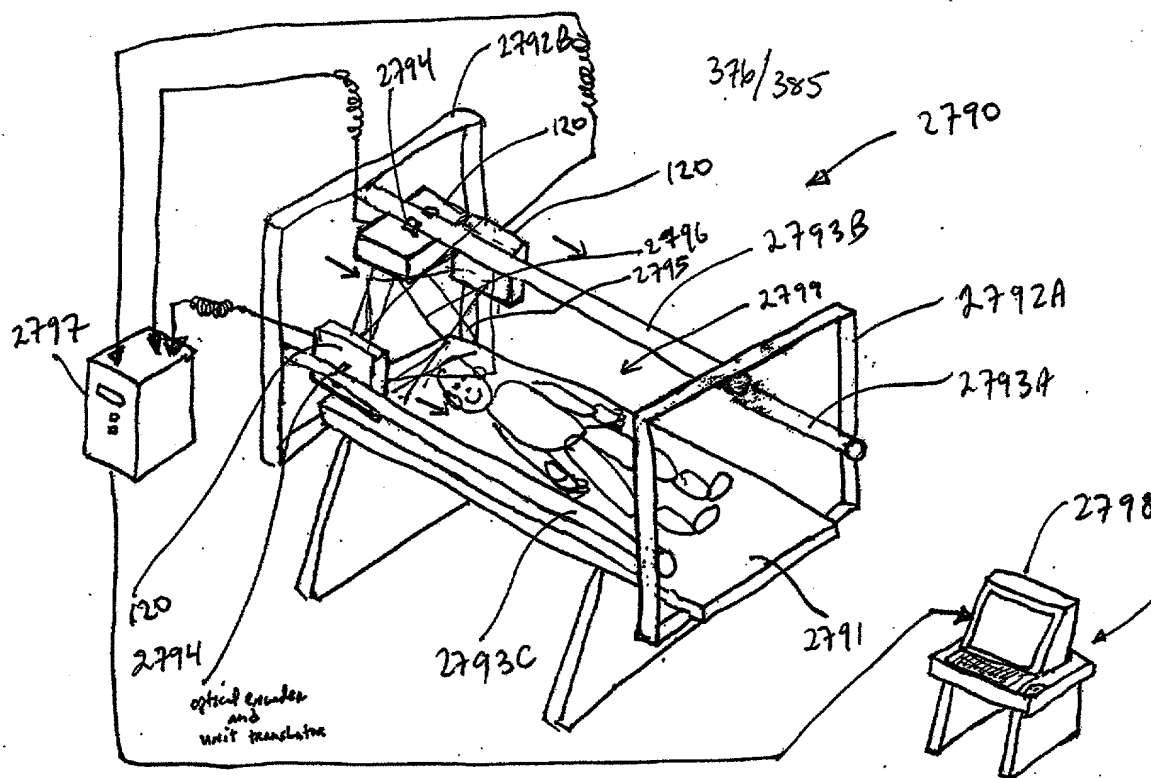


FIG. 74



3-D PLIM-Based  
CAT Medical Scanning  
System

FIG. 75

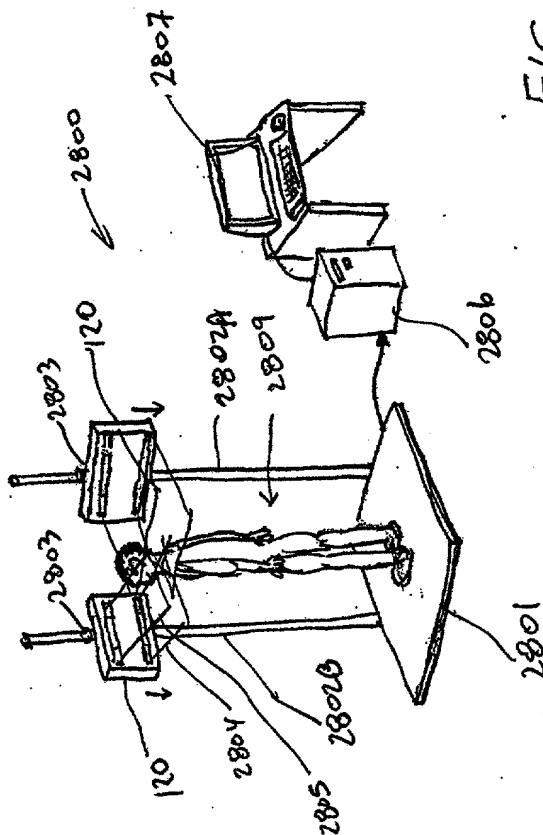


FIG. 76

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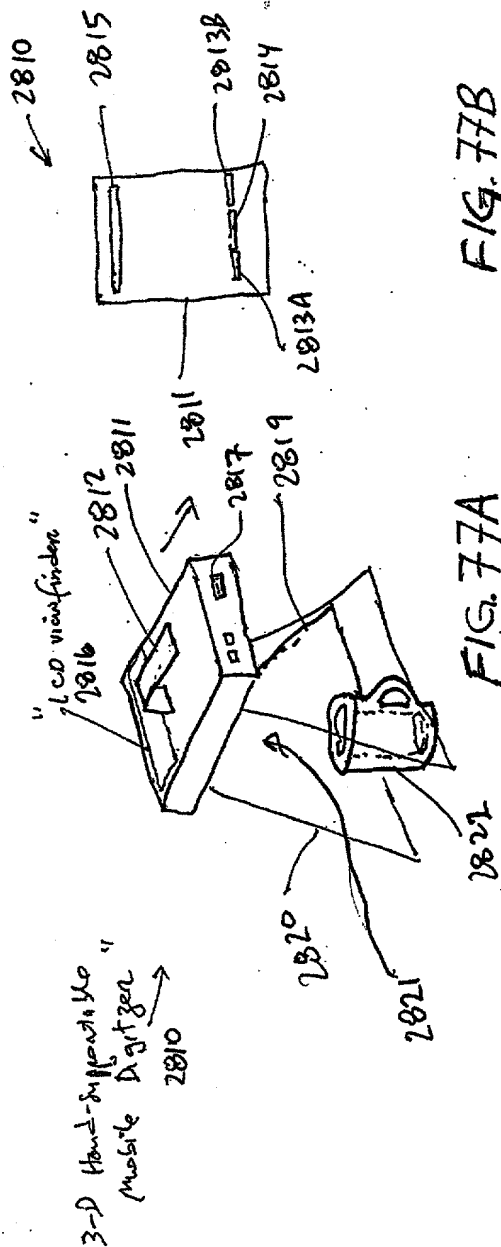
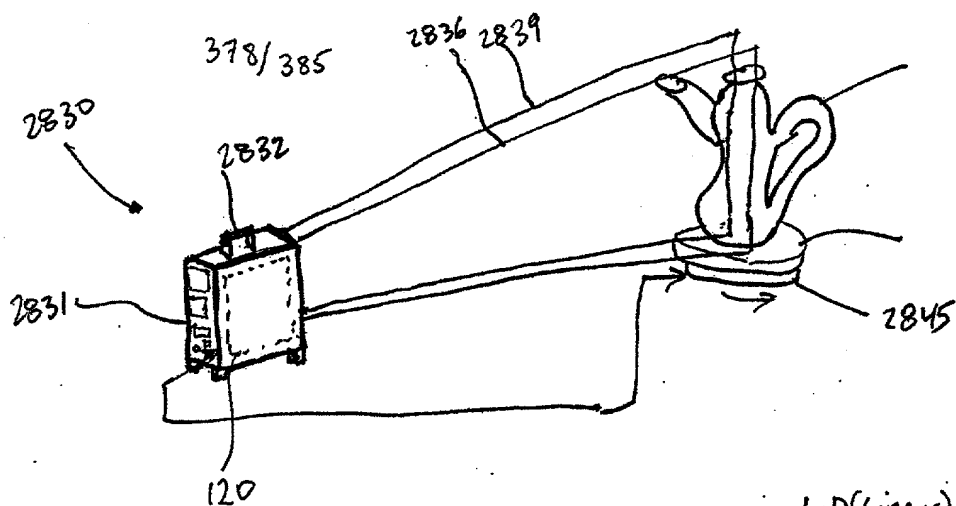
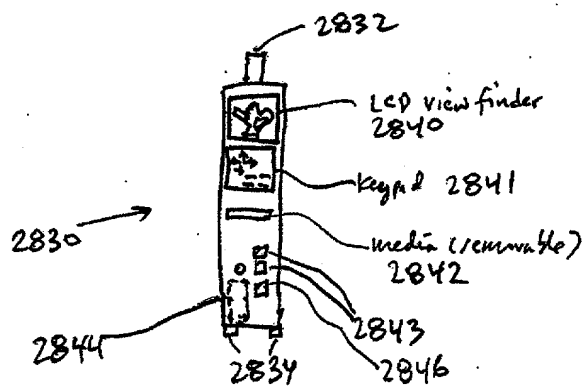
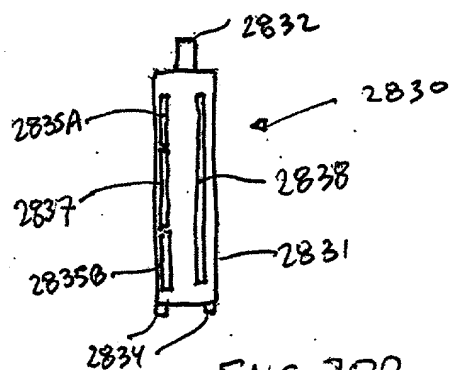


FIG. 77A

FIG. 77B



1-D (Linear) sensor



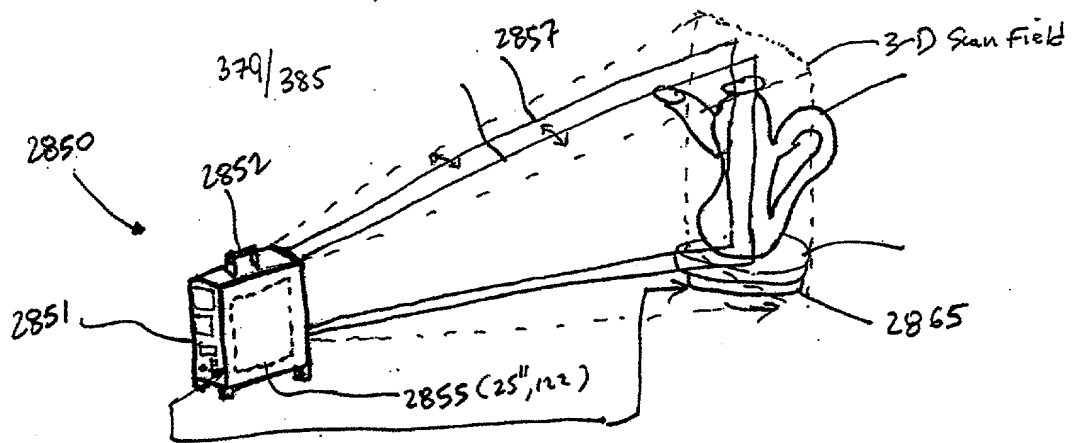


FIG. 79A

3-D (Area) sensor

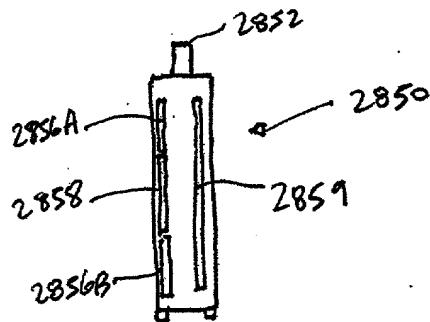


FIG. 79B

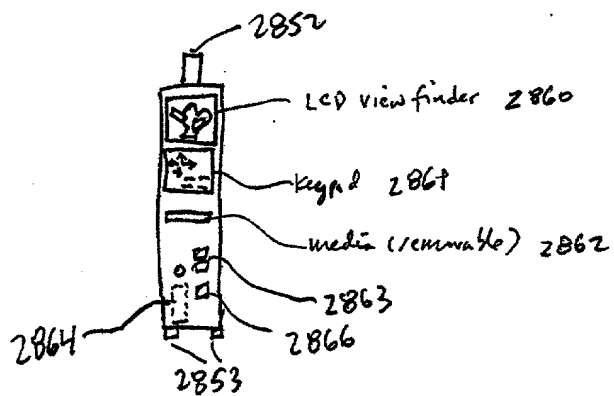


FIG. 79C

Automatic Vehicle Identification (AVI)  
System of present invention

\* employing overhead profiling  
and imaging, sharing  
license plate image capture

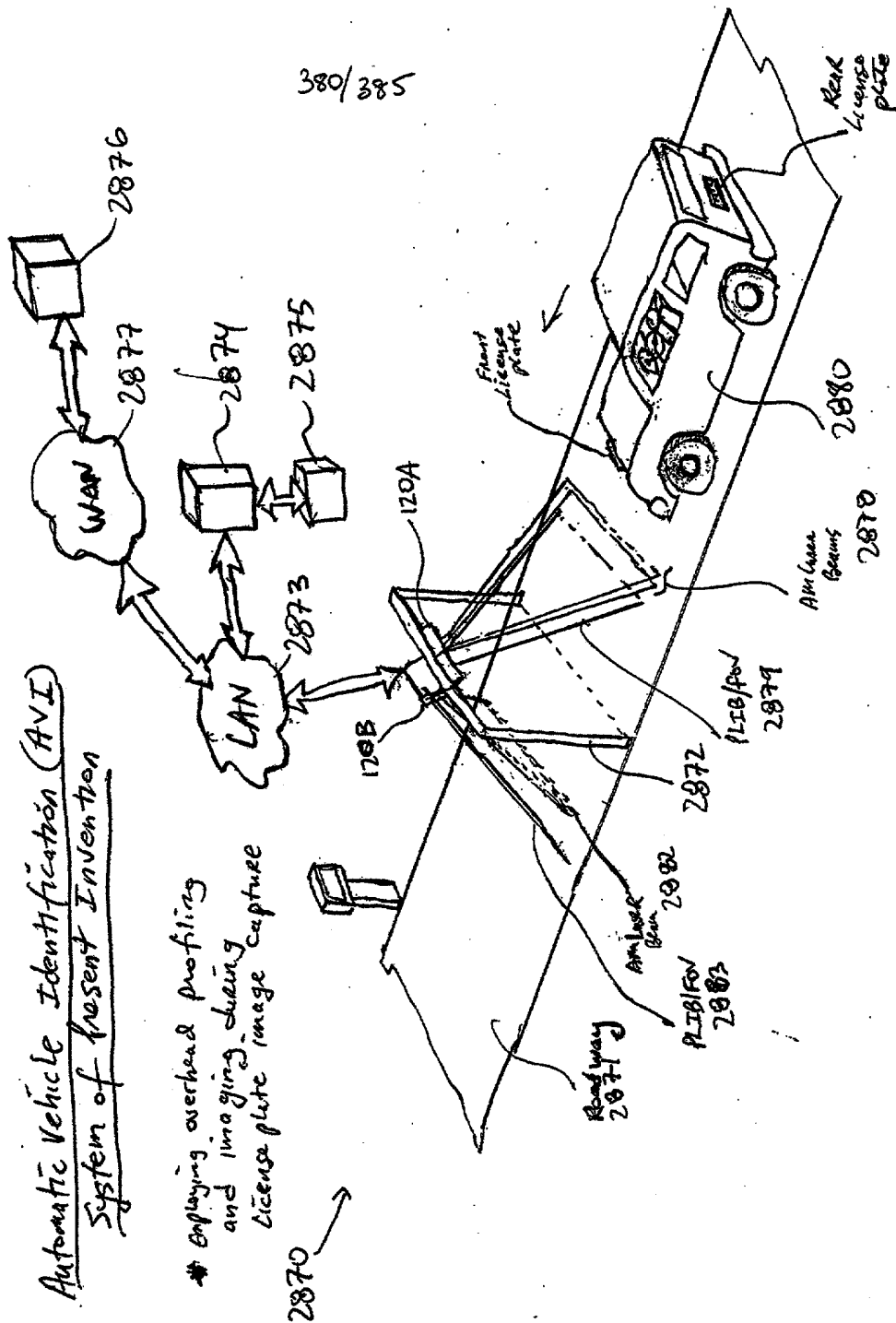


FIG. 80





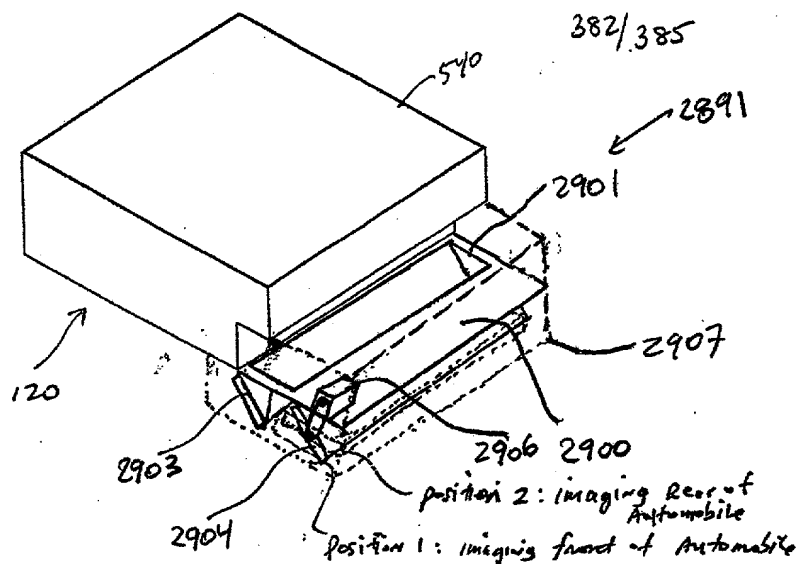


FIG. 81B

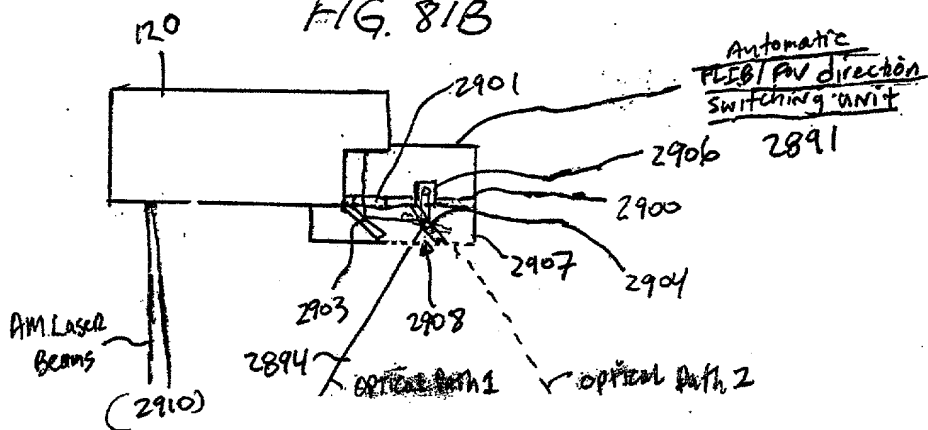


FIG. 81C

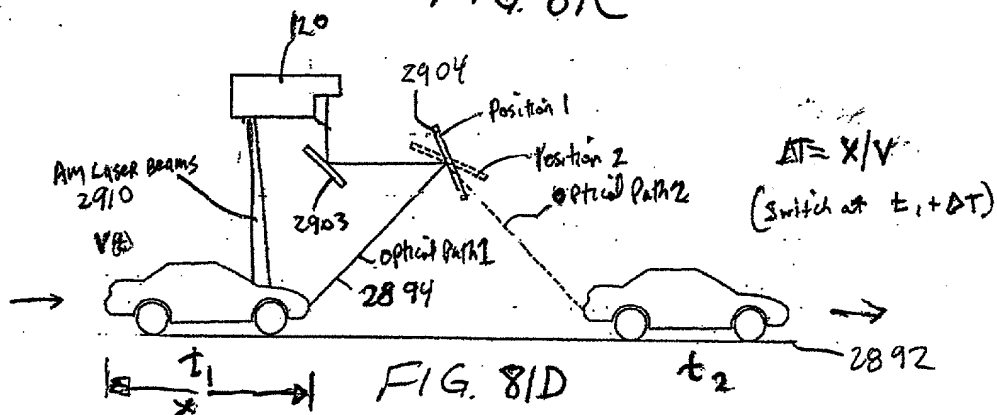
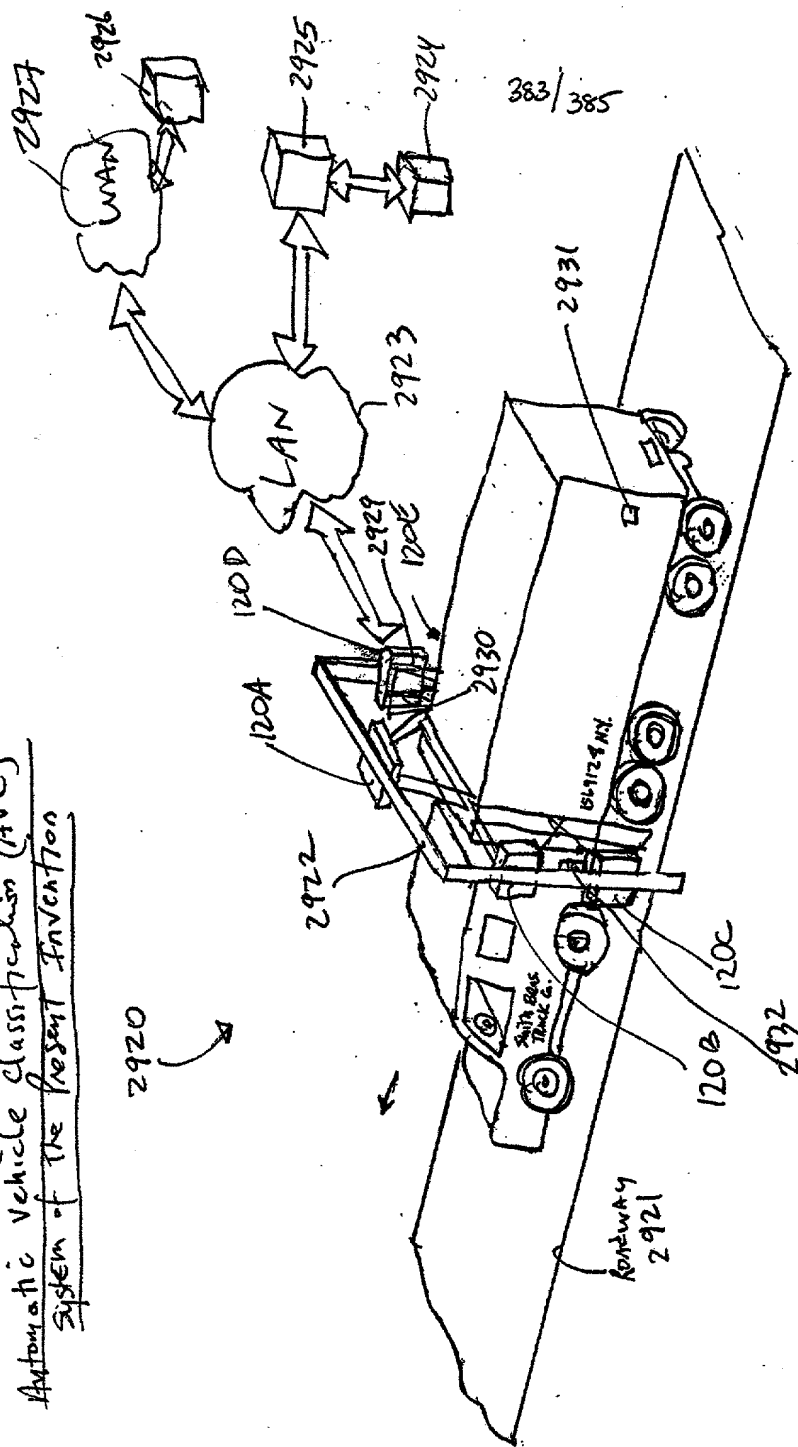


FIG. 81D

Automatic Vehicle Classification (AVC)  
System of the Present Invention

2920



\* Employing overhead and lateral  
profiling and imaging  
techniques

FIG. 82

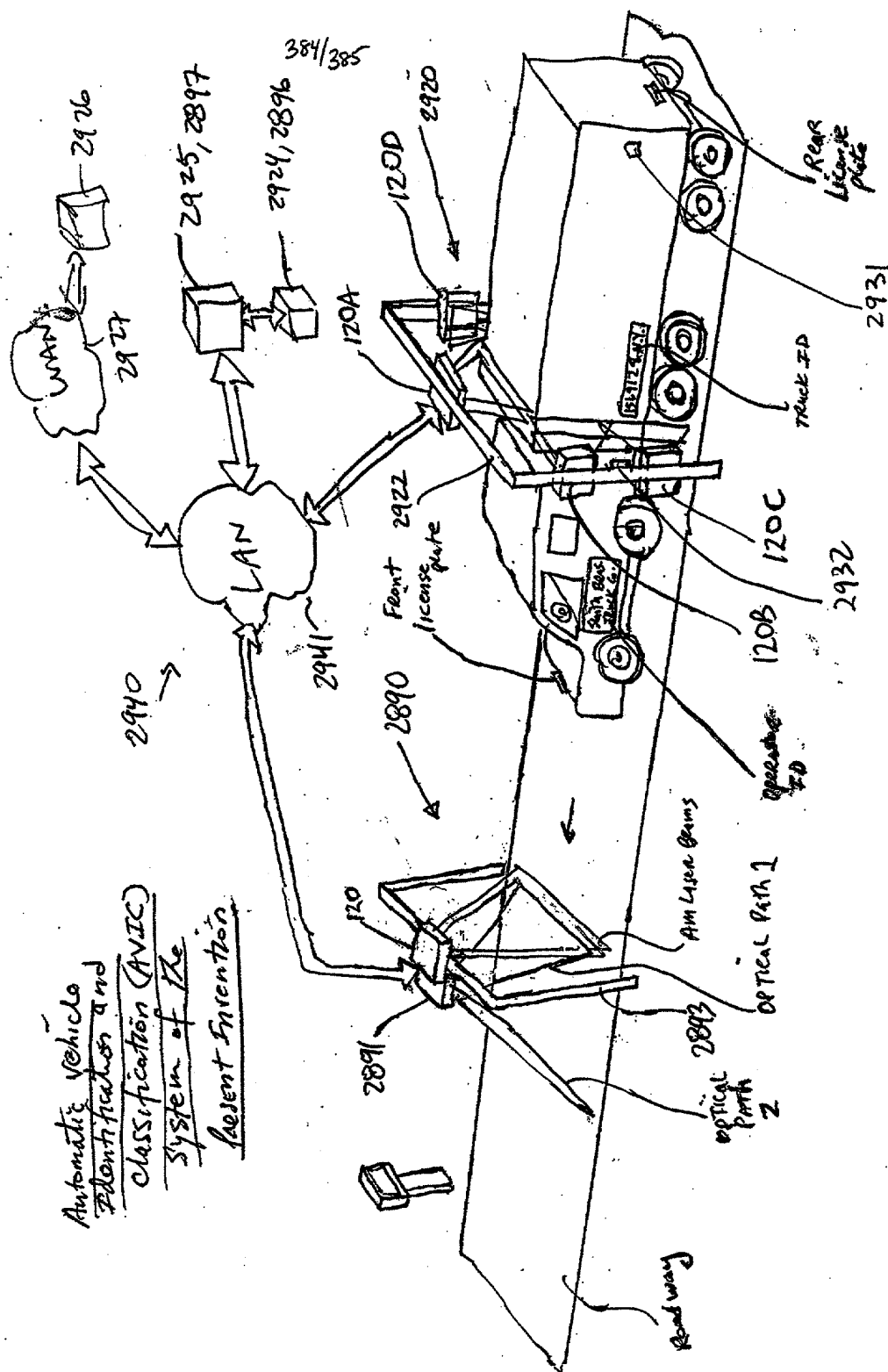


FIG. 83

